DOCUMENT RESUME

ED 220 278 SE 038 803

AUTHOR	Kahle, Jane Butler
TITLE	Double Dilemma: Minorities and Women in Science Education.
INSTITUTION	Purdue Research Foundation, Lafayette, Ind.; Purdue Univ., Lafayette, Ind.
SPONS AGENCY	National Inst. of Education (ED), Washington, DC.
REPORT NO	ISBN-0-931682-13-4
PUB DATE	82
GRANT	NIE-G-78-0233
NOTE	180p.
AVAILABLE FROM	Office of Publications, Purdue University, South Campus Courts-D, West Lafayette, IN 47907 ($5.95).
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	Academic Achievement; Biology; Blacks; *College Science; *Females; Higher Education; Minority Groups; *Minority Group Teachers; *Professional Development; Professional Training; Science Education; Scientists; Secondary Education; Secondary School Science; Student Characteristics; Teacher Characteristics; *Teacher Improvement; Undergraduate Students; *Women Faculty
IDENTIFIERS	*Science Education Research

ABSTRACT

The 3-year project reported in the first chapter of this document addressed factors which affect the scholarly research and publication productivity of women faculty in minority institutions, specifically women in science/science education from colleges affiliated with the Alabama Center for Higher Education. The project was conceived, reviewed, and funded on the premise that improving research and writing skills would increase the professional status of women faculty at minority institutions of higher education. Additional chapters focus on women in science and science education (chapter 2), considering training/retention of women scientists, women in science in academe, and minority women; minority science education (chapter 3), examining minority institutions of higher education and minority science education in secondary schools and colleges; a profile of southern minority undergraduates (chapter 5); and recommendations, participants, participating institutions/students in chapter 6. Six research studies completed by project participants are presented in chapter 4. Issues examined in the studies include: ability/aptitude and characteristics of black college students; effects of instructional methods on achievement; factors affecting biology achievement; efficacy of spatial ability and other measures in predicting mathematics of minority students; urban minority characteristics related to biology achievement; and classroom verbal behavior patterns as indicators of locus of control orientation. (Author/JN)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED220278

Double Dilemma

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION
CENTER (ERIC)

☑ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

● Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY

National Inst. of Education

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Jane Butler Kahle

Double Dilemma: Minorities and Women in Science Education

By Jane Butler Kahle

Purdue University
West Lafayette, Indiana

Book design by Scott Wannemuehler
Cover photograph by David Umberger

The research report herein was developed under a contract from the National Institute of Education, Department of Health, Education, and Welfare. However, the content does not necessarily reflect the position or policy of that agency, and no official endorsement of these materials should be inferred.

Copyright ©1982 by Purdue Research Foundation, West Lafayette, Indiana 47907. All rights reserved. Unless permission is granted, this material shall not be copied, reproduced, or coded for reproduction by any electrical, mechanical, or chemical processes, or combinations thereof, now known or later developed.

Library of Congress Catalog Card Number 81-84383
International Standard Book Number 0-931682-13-4
Printed in the United States of America

Contents

Tables ix

Figures xi

Preface xiii

Forewords xv

Minorities and Women's Program xv
Alabama Center for Higher Education xvii

1 A Cooperative Pursuit of Excellence 1

Introduction 1
National Institute of Education 2
Minorities and Women's Project 7
Cooperating Institutions 11
Summary 20

2 Women in Science and Science Education 23

Introduction 23
Training and Retention of Women Scientists 24
Women in Science in Academe 35
Minority Women 42
Summary 44

3 Minority Science Education 48

Introduction 48
Minority Institutions of Higher Education 48
Minority Science Education 53
Summary 62

4 Reports from the Field 64

Preface 64
An Investigation of Ability/Aptitude, Personal, and Social Characteristics of Black College Students 64

A Comparison of the Effect of Three Instructional Methods on Achievement of Biology Students in a Black Southern College 75

An Investigation of Factors Affecting Biology Achievement of Minority College Students 85

The Efficacy of Spatial Ability and Other Selected Measures in Predicting Mathematics Achievement of Minority Students 91

Urban Minority Student Characteristics Related to Achievement in an Introductory Biology Course 98

Classroom Verbal Behavior Patterns as Indicators of Locus of Control Orientation 104

5 A Profile of Southern Minority Undergraduates 111

Introduction 111
Demographic Data 112
Profile of Undergraduates 117
Summary 134

6 Reflections and Recommendations 138

Introduction 138
Participants 138

Participating Institutions 140
Participating Students 145
Summary 148

Appendices 151

A Biographies of Participants 151
B Consultants and Staff 154
C Demographic Survey 159
D Standardized Instruments 163

Tables

1.1 Program Groups of the National Institute of Education 5
1.2 NIE Funding by Program Groups during Fiscal Years 1974, 1977, 1978, and 1979 6
1.3 Timetable of Cooperative Curriculum and Degree Programs 14
2.1 Undergraduate Enrollments of Women by Field, Fall 1978 25
2.2 Percent of Degrees Earned by Women, 1951–52 to 1975–76 28
2.3 Percentage of Total Degrees Awarded to Women by Content Area in 1975–76 30
2.4 Number and Percent of Women Doctoral Scientists and Engineers in the Labor Force by Field, 1977 33
2.5 Percentage of Women Scientists and Engineers in the Labor Force by Degree Level, 1975–78 34
2.6 Median Annual Salaries of Doctoral Scientists and Engineers by Field and Sex, 1973 and 1977 36, 37
2.7 Women as Percentage of Total Full-Time Faculty Members, 1979–80 38
2.8 Average Salaries of Full-Time Faculty Members, 1979–80 39
2.9 Women Chief Executive Officers in Colleges and Universities 40
3.1 Sources of Funding for ACHE Operations Initiated between 1971 and 1976 50, 51
3.2 Enrollment Trends of Participating Four-Year Colleges and Universities 52
3.3 Percentage by Race Enrolled in Science Courses in 44 Public High Schools in Northern Florida 56
3.4 Minority Students Representation among Degrees Granted in Engineering and Science 59
4.1 Demographic Data: Percentages Describing Personal and Community Characteristics 67
4.2 Pearson Product Moment Correlation Coefficients for Aptitude and Ability Variables 68
4.3 Summary Table: Stepwise Multiple Regressions 68
4.4 Pearson Product Moment Correlation Coefficients for Selected Variables 69
4.5 Pearson Product Moment Correlation Coefficients for Selected Demographic Variables 70
4.6 One-Way Analysis of Variance for GEFT Scores and Selected Measures 72
4.7 Descriptive Data by Treatment for All Subjects 80
4.8 Total Points and Means by Semester for Selected Measures 80

4.9 One-Way Analysis of Variance Comparing Pre-Test Means for Three Treatment Groups by Semesters 81
4.10 One-Way Analysis of Variance Comparing Post-Test Means for Three Treatment Groups by Semester and Neuman-Keuls Subsets 82
4.11 Significant Pearson Project Moment Correlation Coefficients between Group Embedded Figures Test and Selected Variables 83
4.12 Pearson Product Moment Coefficients between Selected Measures and Final Achievement in Biology 88
4.13 Background Data in Percentages 92
4.14 Mean Score for All Measures and Course Grade by Gender 93
4.15 Pearson Product Moment Correlation Coefficients for Selected Variables 94
4.16 One-Way ANOVA of Total SCAT Mean Scores by Treatment Groups 99
4.17 Demographic Data for Urban Junior College Biology Students from Two Successive Quarters 100
4.18 Descriptive Statistics for Pre-Tests of Achievement, Attitude, Learning Style, and Spatial Experience 101
4.19 One-Way Analysis of Variance of Post-Test Mean Scores by Treatment Groups 102
4.20 Comparison of Nowicki-Strickland Assessment with Number and Length of Response 107
5.1 Demographic Data: Personal Characteristics of Southern Minority Students by Percent 114
5.2 Demographic Data: Family Characteristics of Southern Minority Students by Percent 115
5.3 Demographic Data: Community Characteristics of Southern Minority Students by Percent 115
5.4 Mean Scores and Standard Deviations for Cognitive and Aptitude Tests 117
5.5 GEFT Mean Scores for Selected Samples of College Students 125
5.6 Internal/External Mean Scores for Selected Samples of College Students 130
6.1 Full-Time Black Enrollment as Percentage of Total Enrollment by Type and Control of Institution, 1976 and 1978 142
6.2 Pearson Product Moment Correlations between Selected Variables 145

Figures

1.1 NIE Laboratories and Research Centers 3
1.2 Support Network of NIE-ACHE-Purdue Project 13
1.3 Locations of Institutions Represented in the Purdue University Project 15
1.4 Admission, Degree, and Demographic Information for Participating Colleges, 1980 16
1.5 Financial Aid Programs at Participating Institutions, 1980 17
2.1 Percentage of Doctorates in Science Awarded to Women by Decades, 1920–70 29
2.2 Percentage of Total Degrees Awarded to Women by Content Area in 1975–76 31
2.3 Percentage of Degrees Awarded to Women since 1970 32
2.4 Demographic Data, Selected Women Faculty at Minority Institutions 45
3.1 Comparison of Majority and Minority Enrollments in High School Science Courses 55
3.2 Percent of Bachelor's Degrees in Science Earned by Minorities by Field, 1975–76 58
3.3 Percentage of Total Degrees Awarded to Black Students by Content Area, 1975–76 60
4.1 Generalized Model of Gowin's "V" 76
4.2 A Sample Gowin's "V" Applied to a Laboratory Exercise on "Biological Molecules Synthesized by Organisms" 77
4.3 Sample Distribution of Student Scores on the Rotter's I/E Scale 89
4.4 Illustration of a Group Embedded Figures Test Item 95
4.5 Relation of the Number of Responses to the Locus of Control Orientations of Six Selected Subjects 108
5.1 Effects of Socio-economic Status on Selected Variables 118
5.2 Percentage of Males and Females by Category 121
5.3 Mean Scores of Males and Females on Selected Standardized Measures 123
5:4 Distribution of Scores on the Group Embedded Figures Test 124
5.5 Percentages of Relatively Field-Independent and Relatively Field-Dependent Students by Community Size 126
5.6 Descriptive Data for Relatively Field-Independent and Relatively Field-Dependent Students 128
5.7 Distribution of Scores on Rotter's I/E Scale 131

5.8 Percentages of Relatively Internal and Relatively External Students by Community Size and Parental Education 132
5.9 Descriptive Data for Relatively Internal and Relatively External Students 133

Preface

The project described in these pages was conceived, reviewed, and funded on the premise that improving research and writing skills would increase the professional status of women faculty at minority institutions of higher education. The project's title, "Advanced Study and Research Skills in Science Education for Women Faculty at Southern Minority Institutions," describes both the purpose and the personnel of the project. Soon after the selection of the participants, however, the scope of the project broadened. The women selected as participants were concerned with the learning of their students, with the administrative and recruitment procedures of their institutions, and with the status and survival of all institutions of higher education for black students. As the women worked to achieve the original goal of increased professional status by improving their knowledge of statistics, their expertise in research design, and their skills in writing and editing, they kept in mind an ultimate goal. That is, the goal of understanding the problems and process of improving science education for minority students. In my opinion, they succeeded beyond anyone's expectations in reaching both goals.

This book describes the results as well as the findings of this project. It is dedicated to the women participants and consultants across the United States who believed in and worked towards its success. Especially, it is dedicated to Bernice Coar Cobb whose personal strength and professional integrity set the project on the right path.

Jane Butler Kahle
October 1981
West Lafayette, Indiana

Forewords

Minorities and Women's Program

In 1972 the U.S. Congress created the National Institute of Education (NIE) as the primary federal agency for educational research and development. The two-fold mission of NIE was to promote educational equity and to improve the quality of educational practice. In 1976 the National Council on Educational Research, the statutory policymaking body for NIE, declared in resolution:

> It shall be the policy of the National Institute of Education to increase the participation of minority persons and women in the research and development efforts of the nation through ensuring that qualified minority firms and individuals and qualified women are given informed opportunity to participate in NIE programs, and through efforts to increase the numbers, qualifications and performance of minority firms and individuals, and women engaged in education R&D.

The NIE Minorities and Women's Program was born out of that resolution. The priority objectives of the program are:

> To assist minority persons and women to participate at an advanced level of educational research;
>
> To assist institutions and organizations to establish policies and practices that (a) enhance participation of minority persons and women in educational research and (b) overcome barriers to recognition of research contributions, perspectives, and interests of minorities and women; and
>
> To develop knowledge, information, and designs that are needed to advance the foregoing objectives.

Given that neither term, "minorities" nor "women," connotes a monoethnic group, the directions of the program have been diverse. The Minorities and Women's Program has supported regional research-development workshops, seminars on special research topics, and projects in federal educational research laboratories. It is probably best known, however, for its grant's program entitled "Experimental Program for Opportunities in Advanced Study and Research in Education."

Three competitions for grants have been held since the inception of the

Minorities and Women's Program, and final awards from the third competition are pending. The 56 grants awarded in fiscal years 1978 and 1979 totaled about $3 million and supported some 1,500 minority and women researchers nationwide. Projects are now located in 37 regions.

The Minorities and Women's Program was pleased to fund the Purdue University project entitled "Advanced Study and Research in Science Education for Women Faculty at Minority Institutions" in its first major grants' competition. The project director recognized that one of the most pragmatic approaches to career enhancement is research publication, particularly for a target group such as the one described in these pages. After more than three years of work, it is gratifying to see fruition of this project's goals in this monograph. As one personally committed to equity in educational research, I am proud to be a part of this venture.

Sharon Artis
Project Officer
Minorities and Women's Program Area
National Institute of Education

Alabama Center for Higher Education

The Alabama Center for Higher Education (ACHE) grew out of a four-week summer conference on interinstitutional cooperation. Eight teams of four faculty members and administrators met at Stillman College in 1967 under a Ford Foundation grant. The conference was initiated and the funds solicited to support it by the presidents of Alabama's eight predominately black colleges. Incorporated in April 1968, a central office was established in Birmingham at that time. The charter members of the consortium constitute the current membership, with the exception of the recently closed Daniel Payne College, which includes: Alabama A&M University, Normal; Alabama State University, Montgomery; Miles College, Birmingham; Oakwood College, Huntsville; Stillman College, Tuscaloosa; Talladega College, Talladega; and Tuskegee Institute, Tuskegee.

As a voluntary consortium charged with the responsibility of promoting interinstitutional cooperation via the development of cooperative programs, the solicitation of funds to support these programs, and assistance with the administration of these programs, the consortium has demonstrated success in utilizing the cooperative approach for the development and expansion of educational programs.

The ACHE is governed by a board of directors composed of the presidents of the member colleges. An advisory board of deputies, made up of a vice president/dean appointed by each institution, works closely with the consortium's executive director in program development. Initial program planning is carried out by faculty and staff committees, chaired by a member of the advisory board, and comprised of a representative from each member institution. Eight to 10 such committees have operated annually.

The central office operation in Birmingham has grown from a staff of one part-time person (director) to a present staff of 32. Having been headed up by three temporary directors, the consortium acquired a full-time executive director in 1970. Dr. Richard Arrington, Jr., served in that capacity until his 1979 election to the position of Mayor of the City of Birmingham. Charlena H. Bray, the present executive director, has a seven-year tenure with the consortium, having held several administrative positions prior to her stint as interim director followed by the appointment as executive director.

As evidenced by staff growth, the ACHE has experienced tremendous growth during the seventies in several aspects: the present operating budget of approximately $800,000 is 20 times that of the 1970 budget; more than two dozen cooperative programs have been developed and implemented; and numerous seminars, workshops, and symposia have been implemented. Further impact is evidenced by the nature of external support for the cooperative programs which has been an annual mix of federal and private dollars.

Program areas of cooperation have been diverse to include: (1) the establishment of an effective linkage between the colleges and rural, predominantly black communities across the state via the Human Resources Research and Development Program which embodies the major tenets of higher education — instruction, research, and service; (2) cultural enrichment programs such as the annual music and art festivals, interchange of performing artists and lecturers; (3) improvement of instruction programs such as the Gerontology Career Preparation Program, the Minority Hypertension Research Program, Collection and Evaluation of Materials about Black Americans, Mini-Grant Program; (4) student enrichment programs to include rural and urban experiential learning programs; (5) service programs such as the Community Acceptance Program which serves offenders and ex-offenders, the Special Veterans Program; the Public Service Employment Program; and (6) the publication of a wide range of documents which reflect the issues and concerns of the consortium members. Reflected in this partial listing are joint programs which extend beyond the boundaries of the consortium members to other postsecondary institutions, such as this linkage with Purdue University.

The challenges presented by the eighties are numerous and complex; certainly the past accomplishments have provided a basis for extending and expanding the concept of cooperation as a strategy for these member institutions to both expand and enrich their educational programs.

Charlena H. Bray
Executive Director
Alabama Center for
Higher Education

ALABAMA CENTER
FOR
HIGHER EDUCATION

1 A Cooperative Pursuit of Excellence

The job of NIE — and of all American educators — is to increase educational achievement in this country. We must move beyond providing simple "opportunity," to ensure not only that people take advantage of opportunity, but that the opportunity is so compelling that they go on to achieve substantial educational skills. We must be particularly concerned with those persons from whom academic eminence has been elusive in the past.

These goals will not be accomplished in a few years, nor perhaps even in a generation. But that is the course we must set.

— Patricia Albjerg Graham, NIE Director, September 7, 1977

Introduction

When in 1978 the National Institute of Education (NIE) released its first request for proposals for its new program area, Minorities and Women, two women — one in Lafayette, Indiana, and the other in Birmingham, Alabama — saw an opportunity too compelling to miss. Jane Butler Kahle, Purdue University, and Bernice Coar Cobb, Miles College, had worked together before. Kahle directed the final stages of Cobb's doctoral dissertation, and Cobb had assisted in a preservice biology methods course, taught by Kahle. Since Cobb's return to Birmingham, they had consulted with one another on several federal and institutional projects. Together and separately, they had struggled with problems of women in academe, such as intellectual isolation, career interruptions, and lack of mobility. In addition, they were aware of the continued need to encourage women to do research and to publish. They had been able to work together in spite of geographical and institutional barriers; they believed they could design a project to help other women. Each represented a different component in higher education, each could contribute unique strengths and skills to such an endeavor, and each was determined to demand the high performance necessary to ensure academic eminence.

This monograph describes the project which resulted from their efforts. Beginning with the funding agency and ending with the participants' original research, the project symbolizes a cooperative pursuit of excellence in educational research. In the three years of its existence, the goals of equality, excellence, and eminence were stressed and, hopefully, reached. However, as Graham suggests, the full impact of the work described in this monograph may be years away.

National Institute of Education

> (a)(1) The Congress hereby declares it to be the policy of the United States to provide to every person an equal opportunity to receive an education of high quality regardless of race, color, religion, sex, national origin, or social class. Although the American educational system has pursued this objective, it has not attained that objective. Inequalities of opportunity to receive high quality education remain pronounced. To achieve quality will require far more dependable knowledge about the process of learning and education than now exists or can be expected from present research and experimentation in this field . . .
>
> (b)(1) In order to carry out the policy set forth in "subsection (a)," there is established the National Institute of Education. . . . (Section 405 of the General Education Provisions Act, as amended, 20 U.S. Code 1221 e, PL 92-318)

With that edict, Congress created in 1972 the National Institute of Education. Furthermore, they instituted the National Council of Educational Research (NCER) as its policy-making body.

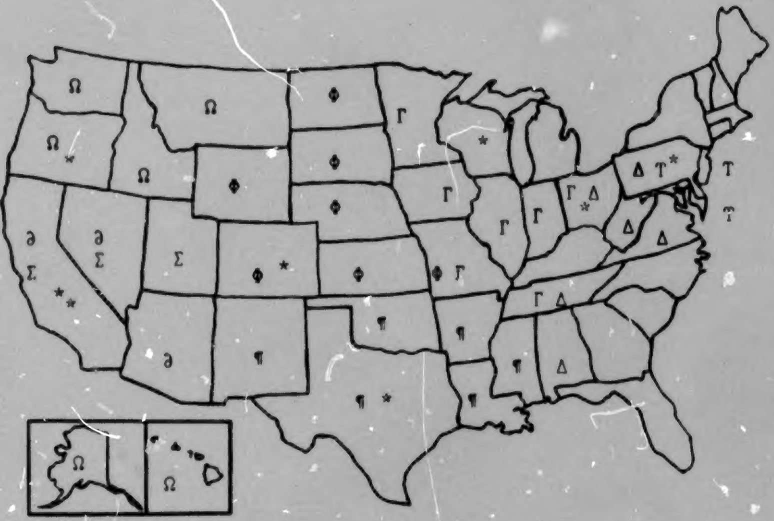
Historical Background

Originally, the National Institute of Education received a mandate to improve education through curriculum reform. It continued the federally sponsored curriculum programs which began in the late 1950s with the National Science Foundation's Course Content Improvement Program. This program had funded and developed curricula primarily in the natural and physical sciences, mathematics, and social studies. Under the auspices of NIE, curricular innovations were expanded into other content areas. Instructional programs, sponsored by the NIE, were developed, coordinated, and implemented by 17 regional laboratories and research centers. Both centers and laboratories were established in the mid-1960s by the U.S. Office of Education, and responsibility for their support was transferred to NIE in 1972. From 1972 until its reorganization in 1977, NIE directed most of its monies toward curricula development and related activities. In addition, approximately one-third of its annual budget was directed toward the support of the centers and laboratories.

The laboratories are independent, nonprofit organizations which serve a specific geographical region. Research centers, on the other hand, are located in exemplary facilities and affiliated with universities.[1] Basically, they differ in the following ways: laboratories emphasize applied research, dissemination, and technical assistance activities; and centers conduct basic research. The locations as well as spheres of influence of both laboratories and affiliated centers are shown in Figure 1.1.

FIGURE 1.1

NIE Laboratories and Research Centers



KEYS: **Regional Educational Laboratories and States Served:**

- Δ Appalachia Educational Laboratory, Inc.
- Γ CEMREL, Inc.
- Σ Far West Laboratory for Educational Research and Development (FWL)
- Φ Mid-Continent Regional Education Laboratory (McREL)
- Ω Northwest Regional Educational Laboratory (NWREL)
- T Research for Better Schools, Inc. (RBS)
- ¶ Southwest Educational Development Laboratory (SEDL)
- ∂ Southwest Regional Laboratory (SWRL)

***National Research Centers** (locations cited in Notes): Center for the Study of Evaluation (CSE), Research and Development Center for Teacher Education (RDCTE), Institute for Research on Educational Finance and Governance (IFG), Learning Research and Development Center (LRDC), Center for Educational Policy and Management (CEPM), Center for Social Organization of Schools (CSOS), Wisconsin Research and Development Center for Individualized Schooling (WRDCIS), National Center for Research on Vocational Education (NCRVE), and National Center for Higher Education Management Systems (NCHEMS).

In 1977, Patricia Albjerg Graham was appointed director of the NIE by President Carter. She undertook an indepth study of the institute and its programs and recommended a reorganization of structure as well as a shift in mission. A major reorganization, approved on March 21, 1978, focused attention on basic and applied research and educational equality and decreased emphasis on curricular reform. It reduced the number of program groups from six to three: Teaching and Learning, Dissemination and Improvement of Practice, and Educational Policy and Organization. These three units and their stated purposes are shown in Table 1.1.

The allocation of NIE funds, shown in Table 1.2 mirrors the change in emphasis. In 1974, 66% of the total budget was directed toward curricula development under the auspices of the units equivalent to the Teaching and Learning section. Less than 20% were allocated to either Dissemination and Improvement of Practice or to Educational Policy and Organization. By 1979, Dissemination and Improvement of Practice received 30% of the total, while the allocation to the Teaching and Learning section was decreased to 49%. The Dissemination and Improvement of Practice program group includes the Minorities and Women's Program and, thereby, is the area primarily concerned with educational equity. Since 1977, a major portion of NIE's budget has been directed toward the equalization of educational opportunities (Schaffarzick and Sykes, 1978).

The ultimate effects of the NIE reorganization and policy reform cannot be assessed at present, but several changes have occurred as a result of the shift in priorities. For example, its sponsorship of curriculum development activities has declined while support for fundamental research has increased. In the future, the institute may sponsor a few large developmental projects. In all but exceptional circumstances, these large developmental projects will be initiated only if they are essential to the equalization of educational opportunity. Concurrently, NIE has redirected its development-related activities to the implementation and dissemination of applied research.

Minorities and Women's Program

Although members of minority groups comprise 17% of the population of the United States and women account for 53% of our population, neither group is adequately represented in the educational research community. For example, less than 7% of educational research is conducted by minority members (Kahle, 1980). Likewise, although women now hold approximately 25% of all faculty positions, they are underrepresented in all activities included under the aegis of research. For example, proportionately fewer women than men sit on research review panels, serve as directors of federal projects, or publish in scholarly

TABLE 1.1

Program Groups of the National Institute of Education

Program Groups	Units	Purpose
Educational Policy and Organization (EPO)	Educational Finance Law and Public Management Educational Organization and Local Communities	To support research in the: 1. Formation and implementation of education policy 2. Institutional and social structures within which people are educated 3. Impact of education policy, management, and financial practice on equal educational opportunity 4. Generation and distribution of revenues for education 5. Relationship between law and education
Teaching and Learning (T&L)	Reading and Language Studies Learning and Development Teaching and Instruction Education in the Home, Work, and Community Testing, Assessment, and Evaluation	To support research in: 1. Human learning and development 2. Processes of instruction, and related subjects
Dissemination and Improvement of Practice (DIP)	Research and Educational Practice Information Resources Regional Programs Minorities and Women's Program	To support research: 1. In the dissemination and utilization of knowledge 2. With activities to increase the availability of knowledge to all in the educational community and others

journals. This overall underrepresentation was one of the major reasons why in 1976, NIE organized a program area specifically for minorities and women. Developmental involvement and research are the main concerns of this sponsored program.

The minorities and women's section of NIE has stated that its purpose is "to strengthen the quality, relevance, and credibility of educational research by encouraging the participation of minority persons and women" (National Institute of Education, 1980). NIE's means of encouragement and support are

TABLE 1.2

NIE Funding by Program Groups during Fiscal Years 1974, 1977, 1978, and 1979

	FY 1974		FY 1977		FY 1978		FY 1979	
Program Groups	%	$M	%	$M	%	$M	%	$M
Teaching and Learning	66	42.6	55	32.0	52	39.7	49	39.2
Dissemination and Improvement of Practice	19	12.2	26	14.9	29	22.2	30	24.5
Educational Policy and Organization	15	9.9	19	10.9	19	14.3	21	16.5
Totals	100	64.7	100	57.8	100	76.2	100	80.2

SOURCE: *Fifth Report of the National Council on Educational Research,* 1981, p. 19.

NOTE: This table reflects the NIE budgets for FY 1978 and FY 1979 under program areas as reorganized in 1978. Budgets for FY 1974 and FY 1977 are shown for comparative purposes as they might have appeared under the present reorganization. This does not include NIE program direction and administrative costs.

institutional grants and special projects. The grants and special projects are instrumental in providing services to minorities and women such as increasing their research skills, providing them with role models, and informing them of access routes to new opportunities. To reach its goal, NIE has formulated the following objectives:

1. Help minorities and women to participate at an advanced level of educational research and related work;
2. Assist institutions to establish policies and practices that
   a. enhance participation of minorities and women in all aspects of educational research;
   b. overcome barriers to recognition of their research contributions, perspectives, and interests; and
3. Develop knowledge, information, and strategies to advance the foregoing objectives (Minorities and Women's Program, pamphlet).

The first director of the Minorities and Women's Program was Dr. Gwendolyn Baker. Under her energetic leadership, the section undertook the task not only of training more women and minority persons but also of encouraging them to achieve higher status. A task force identified three barriers which inhibited full participation by these groups:

1. Limited access to advanced training;
2. Insufficient access to formal and informal networks relating to research and publishing; and

3. Lack of role models (Baker and Hartley, 1979, p. 3).

In order to eliminate or to eradicate these barriers, the Minorities and Women's Program sponsors both institutional grants and special projects. Long-term institutional grants are awarded to the laboratories, the research centers, and to institutional projects that increase the awareness of women and minorities to opportunities existing within universities and other institutions. These grants are designed to provide research and leadership positions for women and minorities. Institutional grants must be supported by a major institutional commitment to equalize the roles and status of women and minorities within the institution.

Special projects, on the other hand, are short-term, smaller grants which do not require an institutional commitment. Many special projects may be instrumental in equalizing opportunities for women by enhancing their research skills, by providing them with role models, and by informing them of new career opportunities. The cooperative effort between Purdue University and the colleges of the Alabama Center for Higher Education (ACHE) was a special project sponsored by the Minorities and Women's Program of the National Institute of Education.

Minorities and Women's Project

Although both women and minorities are underrepresented in educational research in general, they are practically invisible in the specialized area of science education research. Since this is the area of expertise of Cobb and Kahle, they proposed a project to enhance the full participation of women in research activities in science education. Kahle's proposal, "Advanced Study and Research Skills for Women Faculty at Minority Institutions" was one of the original eight special projects funded by the minorities and women's section in 1978. Subsequently, it received two additional years of funding, bringing the total period of support from October 1, 1978 to December 30, 1981.

Goals and Objectives

The project addressed many factors which affect the scholarly research and publication productivity of women faculty at minority institutions. Specifically, the target population was women in science[2] and science education from the colleges affiliated with the Alabama Center for Higher Education.[3] It was designed to assist these women through the total process of research and dissemination of findings by their participation in two summer workshops at Purdue University, by their investigation of a research problem on their home campuses, by their presentation of invited papers at national conventions, and by their preparation of research papers suitable for publication in refereed journals.

Specifically, the project addressed the following eight objectives:

1. Upgrade the research skills of women faculty from minority institutions;
2. Implement rigorous standards for educational research, based upon a model of paradigm-based research which may be replicated by independent investigators on separate campuses;
3. Develop self awareness and confidence among the participants so that they become more effective faculty members at their home institutions;
4. Provide professional sponsorship, mentorship, and collaborative arrangements between primarily teaching faculty at small minority colleges and experienced women researchers from a variety of institutions and professional positions;
5. Enhance opportunities for dissemination and publication of research by women faculty on minority campuses by arranging for seminar presentations at two national meetings of appropriate professional organizations, by providing detailed information concerning publications, and by using editors of science journals as part of the instructional staff;
6. Enhance career opportunities of women faculty at minority institutions by providing them with an understanding of research procedures necessary for productive, rigorous research;
7. Establish a supportive network between a southern consortium of minority colleges and a major university so that each becomes cognizant of the potential opportunities for further faculty and student exchanges as well as research opportunities unique to each campus; and
8. Increase awareness of the problems facing women (especially minority women faculty who routinely have heavy teaching duties and thus fewer opportunities for research and professional advancement) at the host and home institutions by actively involving key administrators in the project.

First Year

The major activities of the first year of the NIE-Purdue project were recruitment and selection of project participants and the planning and implementation of a month-long training workshop. To recruit participants, the following items were developed: a publicity brochure describing the project, a comprehensive application form, and a personalized recruitment plan which reached a maximum number of potential applicants. The project's success owes much to the recruitment activity. Cobb, associate director of the project, solicited the help of the director of ACHE with publicity, and Cobb personally visited each campus in the consortium. Since the number of women in science and in science education was small, she also visited other campuses in Alabama and Georgia, met with prospective participants, and discussed with them both the specific details of the project and any general concerns (such as living arrangements and "atmosphere" of a large, rural, midwestern campus). Applicants frequently voiced a fear of failure but the reassuring approach of both Cobb and Kahle mollified that concern. Since the director and associate director knew that the faculties of the target colleges were integrated, they anticipated a racially mixed group of applicants. The applicants chosen were all black women who were characterized by the Myers-Briggs personality scale as confident, extroverted types. Information concerning their academic preparation as well as their faculty status is given in Chapter 2.

When the participants had been selected and their applications and other communications had been studied carefully, a seminar series and an overall research design was developed. The four-week workshop in the summer of 1979 was primarily an intensive training period in advanced research techniques. The first week's activities concerned women in academe and paradigm-based research. The second week's activities consisted of considerations of educational measurement techniques and of research constraints. During the third week, intensive sessions on the statistical analysis of data as well as individual conferences concerning areas of research interest were held. The last week of the workshop involved additional seminars concerning research design and evaluation methodologies.

All of the workshop activities promoted the development of collaborative arrangements and relationships among the participants and consultants. Approximately 20 consultants, primarily women, were involved in teaching and in presenting seminars during this period. Although their individual contributions are too lengthy to be credited, they are acknowledged in Appendix B. Indeed, their contributions of time, information, and advice were unselfish and remarkable. Mentorship and role-model relationships were fostered which are still flourishing.

During this period, the participants also developed a battery of background questions, applicable to student populations in each institution represented. Standardized measures of attitude, of spatial experience, of locus of control orientation, of cognitive style, of achievement, and of school ability were selected. These measures are described in Appendix D. This initial phase provided the background the participants would need to carry out their projects and to continue to participate in research and writing.

Second Year

The major activity of the second year of the project was the implementation of research projects by the participants. At the completion of the initial summer's workshop, the participants returned to their home campuses with research problems to investigate and a number of standardized measures to administer. Carrying out their research projects required most of the 1979–1980 academic year. The availability of computer facilities and of assistance in data analysis on their home campuses was a major concern, expressed by the participants during their stay in Lafayette. Therefore, data were collected, sent to Purdue University for analysis, and returned to the individual researchers for interpretation. The analyses used were selected jointly by the senior research associate and the participants. During this second year, each active participant completed a preliminary paper for presentation at a national conference.*

Three participants presented their research papers as part of a symposium at the 1980 Association for Educators of Teachers of Science meeting held in conjunction with the National Science Teachers Association's annual convention. The remaining five participants presented papers at the 1980 National Association for Research in Science Teaching annual meeting. The papers were particularly well received at this meeting. The session during which these papers were delivered was filled with concerned leaders from the science education community, who commended the authors on their work and on their diligence in conducting research in situations not generally conducive to such activities.

Prior to the second summer's workshop, each participant's paper was critically reviewed by the project director and by editors of science education journals. These editors were the primary staff for the second workshop and are listed in Appendix B. Their reviews made possible immediate revisions and new statistical analyses once the participants reconvened at Purdue University. The second summer's activities were condensed into a three-week period during July, 1980. Throughout the workshop, original manuscripts were rewritten by participants and critiqued by staff and participants as well as by a science editor from a major publishing house.

During the second year of the project, a viable network among women faculty on the campuses of the ACHE consortium was successfully established. In addition, strong, supportive contacts were continued between the participants and a wide variety of women and men in science, science education, publishing, and research. Furthermore, participants had been guided through the first two phases of productive research. That is, they had conducted an experimental research project, and they had presented their findings in both oral and written reports.

Third Year

Dissemination was the primary objective of the third year of the project, and it was implemented in four ways:

1. Submission of each participant's article to an appropriate journal;
2. Revision of participant articles for submission to the Anniversary Issue of the *Journal of Negro Education;*
3. Preparation of the final monograph; and
4. Presentation of a wide variety of papers and seminars by both project director and associate director and by project participants.

Successful publication of participant papers completed the full circle of advanced study skills which were the original goal of the project. Participants had designed and implemented a research project and had written and published their findings. In addition, they had updated their research and statistical skills and had interacted cooperatively with many members of the science education community. In other words, they had taken their rightful place in the mainstream of the science education research community.

The project has had a significant impact on both the host institution, Purdue University, and the home institutions of the participants. Numerous faculty and administrative personnel at Purdue and in home institutions have contributed their time and expertise to the project and interacted with the participants. A supportive network has been established between the cooperating institutions as faculties shared in research projects. It is expected that the training in advanced research techniques, the actual presentations and publications of research papers, and the mentor relationships established will increase the future participation in educational research of the minority women involved in the project.

Cooperating Institutions

Four southern colleges and universities under the aegis of the Alabama Center for Higher Education as well as Atlanta Junior College cooperated with Purdue University in this project. Figure 1.2 illustrates the interinstitutional nature of the project and lists the individual participating components.

Alabama Center for Higher Education

The Alabama Center for Higher Education (ACHE) includes seven predominantly black senior colleges in Alabama, four of which had faculty members involved in this project. ACHE promotes expansion and enrichment of educational programs at its member institutions while minimizing their operational expenses. Interaction and cooperative efforts among the seven colleges are also encouraged. As the consortium continues to grow, it demonstrates its success in the diverse programs it sponsors. Brief descriptions of a variety of its activities illustrate the depth and breadth of the consortium's involvement in higher education in Alabama.

"Communiversity" is the name of ACHE's Community Outreach Program. Individual outreach efforts throughout Alabama are included in the "communiversity" concept. Outreach programs include the following activities:

1. The Cooperative Counseling and Recruitment Program furnishes rural, college age students with access to higher education.
2. The Admissions and Recruitment Program provides each college with an additional full-time recruitment and admissions employee, with travel funds for recruitment, and with help in developing and producing promotional literature.
3. The Special Veterans Program aids disadvantaged veterans who are educationally deprived, unemployed, and underemployed.
4. The Special Services Penal Program provides courses at the college level and below for persons incarcerated at two of Alabama's correctional institutions.
5. The Human Resources Research and Development Program provides additional rural community outreach services such as fiscal management training and community development research, as well as analyses of local governments, community agencies, economic cooperatives, and civic organizations.

ACHE also sponsors the Cooperative Cultural Enrichment Programs which include a weekly, 30-minute television broadcast entitled "Profiles of Black Culture," an annual musical festival, and an annual art festival. In addition, it sponsors lectures, concerts, and performances at the colleges in the consortium. This collaboration results in quality programs at lowered costs to the member institutions.

Innovative academic foci under ACHE aegis assure high quality educational programs for increasing numbers of students and faculty. Four well-established programs are: Cooperative Curriculum and Degree Programs, Cooperative Academic Internship Program, Faculty Mini-Grant Program, and

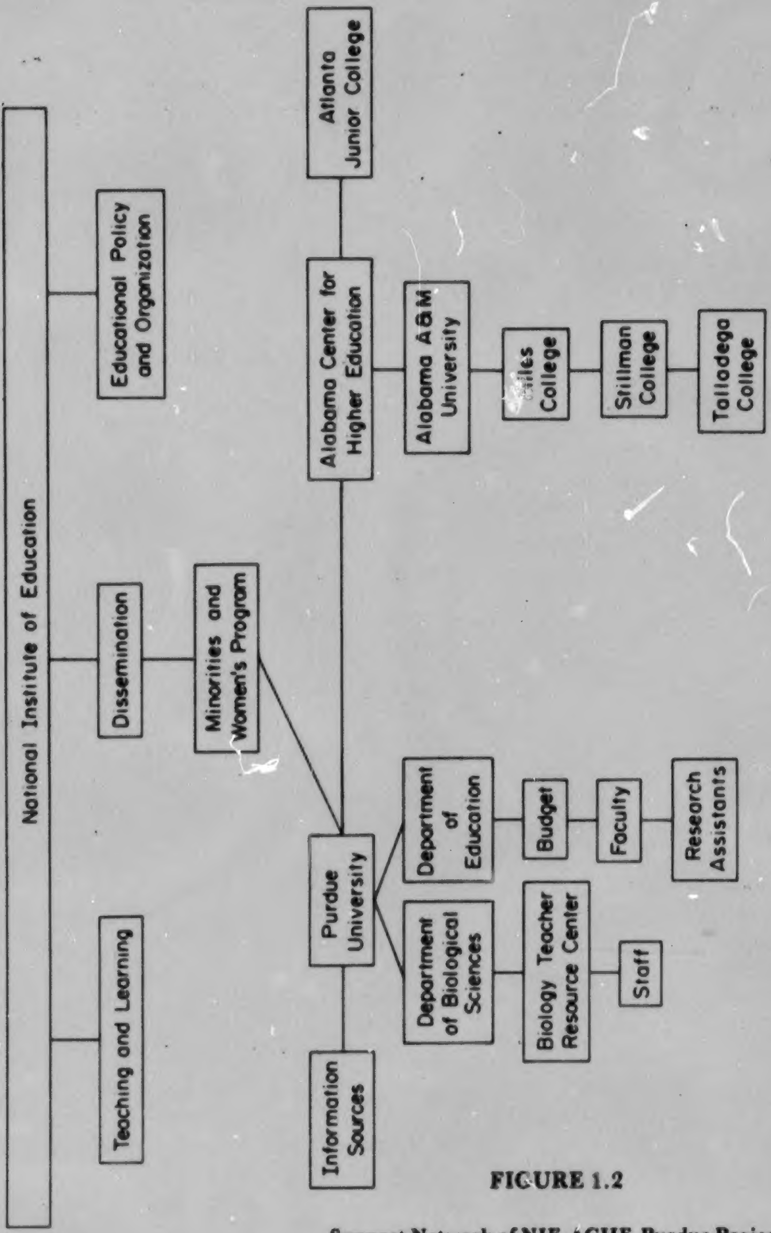

National Institute of Education
Teaching and Learning
Dissemination
Educational Policy and Organization
Minorities and Women's Program
Information Sources
Purdue University
Alabama Center for Higher Education
Atlanta Junior College
Department of Biological Sciences
Department of Education
Biology Teacher Resource Center
Staff
Budget
Faculty
Research Assistants
Alabama A&M University
Miles College
Stillman College
Talladega College

FIGURE 1.2

Support Network of NIE-ACHE-Purdue Project

Gerontology Training Program. Of particular interest to science faculties and students are the Cooperative Curriculum and Degree Programs in which students enroll in dual degree programs. They begin their higher education at a home institution, transferring to Tuskegee Institute to complete their course work in veterinary medicine, engineering, or architecture. In this way, they first matriculate at a smaller institution and at a lower cost. Degrees are awarded by both the home institution and Tuskegee. Table 1.3 presents the timetable and degree options offered through this program.

TABLE 1.3

Timetable of Cooperative Curriculum and Degree Programs

Program	Years at Home Institution	Years at Cooperating Institution	Degree
Engineering	3	2	B.A.*, B.S.**
Veterinary Medicine	2	2 + 2	B.S.*, D.V.M.**
Architecture	3	2	B.S.**

SOURCE: *Alabama Center for Higher Education Bulletin.*

*Home institution; **Tuskegee Institute.

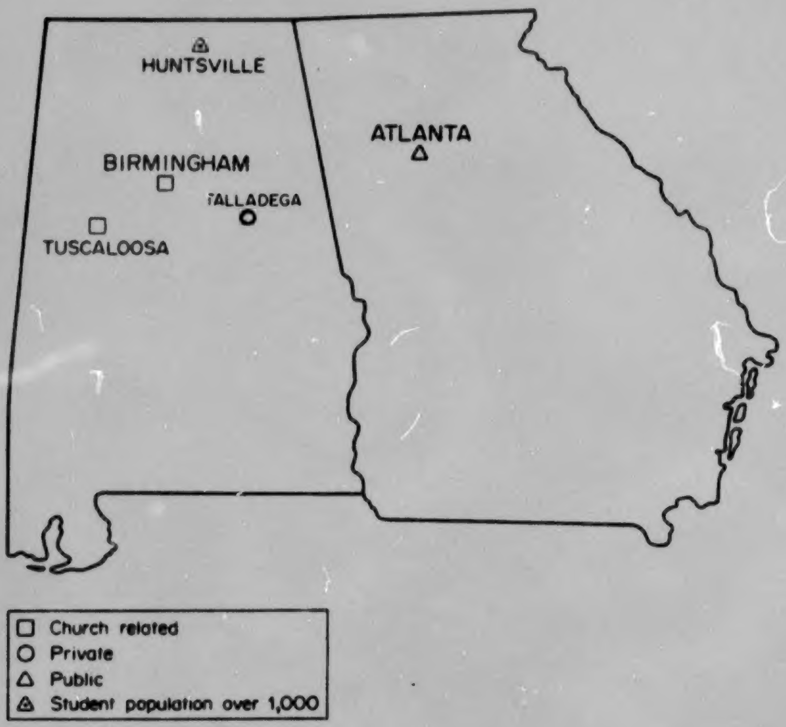
Ethnic heritage is a prime concern of the administrations, faculties, and students of ACHE's member institutions. Three major programs provide historical and cultural information about black Americans. First, the Collection and Evaluation of Materials about Black Americans Program collects and provides library materials regarding the history of Afro-Americans. In addition, this program coordinates ACHE's Ethnic Heritage Program. Second, the statewide Oral History Project acquires information for the black community about the civil rights movement in Alabama. This information, useful for understanding past and present struggles for equality, is available for research studies as well as for instructional purposes. Third, the Ethnic Studies Research and Curriculum Development Program hopes to incorporate black heritage materials into the curricula of colleges and high schools in Alabama. It also aids the Oral History Project by focusing on the literature, music, and folklore of black Alabamians.

These diverse programs are only a sample of the many activities sponsored by ACHE. It publishes a newsletter and helps to publicize projects such as the one described in this monograph. Both the past executive director of ACHE, Richard Arrington, currently mayor of Birmingham, and the current director, Charlena Bray, lent their personal and professional prestige to the inception and completion of this project.

Representatives of four ACHE campuses participated in the Purdue University project. These institutions happen to be geographically clustered in the northern half of Alabama, as shown in Figure 1.3. Of the colleges represented, two are public institutions, two are church-related, and one is private, nondenominational. They have student bodies ranging in size from 650 to over 4,600. Degree programs offered at one or more of these institutions range from Associate of Arts, to Bachelor of Arts and Bachelor of Science, to Master of Science. Although several of the colleges have open admissions policies, all specify ad-

FIGURE 1.3

Locations of Institutions Represented in the Purdue University Project


◬ HUNTSVILLE
ATLANTA △
BIRMINGHAM □
TALLADEGA ○
□ TUSCALOOSA
□ Church related
○ Private
△ Public
◬ Student population over 1,000

mission criteria. Figure 1.4 compares admission requirements to degrees conferred and demographic data from the colleges with participating faculty. One of the primary deterrents to the higher education of blacks is lack of adequate funds. This concern will be presented historically in Chapter 3. However, as Figure 1.5 illustrates, all of these institutions offer a variety of federal and state aid programs. Collectively, the colleges represented are primarily small, black institutions which confer baccalaureate degrees. A discussion of their individual differences and strengths follows.

Alabama Agricultural and Mechanical University

Alabama A&M University is located in the business district of Huntsville, Alabama, a city of 150,000 people which also has a major space and electronic

FIGURE 1.4

Admission, Degree, and Demographic Information for Participating Colleges, 1980

	Alabama A and M University	Atlanta Junior College	Miles College	Stillman College	Talladega College
Admission Requirement	High School Diploma SAT or ACT Test Scores	High School Diploma SAT Test Scores	High School Diploma ACT Test Scores	High School Diploma SAT or ACT Test Scores	High School Diploma SAT or ACT Test Scores
Highest Degree Offered	MS	AA	BS, BA	BS, BA	BS, BA
Number of Students	4,600	1,700	800	650	712
Number of Faculty	322	59	104	57	80
Percent PhD	29	19	22	17	34

FIGURE 1.5

Financial Aid Programs at Participating Institutions, 1980

FINANCIAL AID		Alabama A and M University	Atlanta Junior College	Miles College	Stillman College	Talladega College
PUBLIC FUNDS	STATE					
	Alabama Student Assistance	●		●	●	
	Georgia Incentive Scholarship		●			
	FEDERAL					
	Vocational Rehabilitation				●	
	Student Loan	●		●	●	●
	Veterans Benefits			●	●	
	College Work-Study	●		●	●	
	NDS	●		●	●	●
	SEOG	●	●	●	●	●
	BEOG	●	●	●	●	●
PRIVATE FUNDS	Part Time Employment	●				●
	Special Loan Funds			●		
	Private Awards			●		
	Insured Bank Loans			●		
	Church			●	●	
	Scholarship	●		●	●	●

research center. On its 800-acre campus, A&M has an enrollment of 4,600 students of which approximately 1,100 are graduate students. The university is a coeducational land-grant institution supported primarily by the State of Alabama and federal funds targeted to meet the objectives of the Morrill Acts of 1862 and 1890. Alabama A&M University is fully accredited by the Southern Association of Colleges. In addition to this comprehensive accreditation, the following professional schools within the university are individually accredited by their respective associations:

1. School of Agriculture and Environmental Science by the Institute of Food Technologists
2. School of Education by the National Council for Accreditation of Teacher Education
3. School of Library Media by the American Library Association
4. Department of Community Planning by the American Institute of Planners.

Miles College

Miles College was established nearly a century ago by the Colored Methodist Episcopal Church. The college, located in Fairfield, Alabama, occupies 35 acres. For most of its years of service, Miles College has been the principal collegiate institution open to black students in the metropolitan area of Birmingham. It serves approximately 800 students in a cooperative association with the University of Alabama in Birmingham. Miles College, a four-year, accredited, liberal arts college, maintains an open admission policy. It is an accredited member of the Southern Association of Colleges and Schools and was voted into membership in the United Negro College Fund in January 1972.

Stillman College

Originally established as a training school for black ministers, Stillman College expanded its educational programs as the need for other academic programs increased. Stillman College is located in Tuscaloosa, Alabama. The 100-acre campus serves a student population of 650. Stillman is a four-year coeducational college which offers the Bachelor of Arts and Bachelor of Science degrees. It is accredited by the Southern Association of Colleges and Schools and is a member of the Association of American Colleges and the American Council of Education.

Talladega College

Talladega College, located in Talladega, Alabama, was the first college opened to blacks in the State of Alabama. It began in 1867 as a primary school. Today, this liberal arts institution serves approximately 700 students. The college is housed in 18 main buildings on 50 of its 130 acres. Talladega College, recognized nationally and regionally, is accredited by the Association of American Universities and the Southern Association of Colleges and Schools.

Atlanta Junior College

One participant in this project came from Atlanta Junior College which is not a member of ACHE. Atlanta Junior College, located in Atlanta, Georgia, is the thirty-second institution of the University System of Georgia. It opened in September, 1974, with an initial enrollment of 504 students and presently serves an interracial population of approximately 1,700 students. The college is located next to Atlanta Area Technical School on an 83-acre wooded tract. Atlanta Junior College is fully accredited by the Southern Association of Colleges and Schools. Credits earned at Atlanta Junior College are accepted by all other units of the University System of Georgia. An associate degree is awarded by this institution after the successful completion of course requirements.

Purdue University

Purdue University, located in West Lafayette, Indiana, is a land-grant coeducational institution with an enrollment of 32,000 students on its main campus. Purdue University has regional campuses at Calumet, Hammond, Fort Wayne, and Westville, Indiana, and offers academic programs at Indiana University-Purdue University at Indianapolis. The academic programs available on the central campus lead to the baccalaureate, master's, and doctoral degrees. Purdue University is fully accredited by national, regional, and many professional agencies. It is a member of the North Central Association of Colleges and Secondary Schools. Purdue University has been selected as one of the 48 member-institutions in the Association of American Universities.

Science Education at Purdue University

Purdue University has a unique science education program due to the strong interests of the science and mathematics departments in quality instructional programs. Excepting elementary science education, all of the science education programs are joint ones between each of the departments of Biological Sciences, Chemistry, Geosciences, Mathematics, and Physics and the Department of Education. The faculty all hold joint appointments between two departments and support in terms of graduate assistants, secretarial staff, facilities, and other materials may come from either department. In general, this pattern has several distinct advantages:

1. Close liasons are maintained within an academic area.
2. Support is more plentiful than would be likely within a single department.
3. The level of graduate students is extremely high as many are attracted to the interdisciplinary program.
4. Graduate training provides opportunities (particularly for guided experience in teaching) in an academic area as well as research in science education. The science/mathematics education faculty form one of seven program areas in the Department of Education.

There is no doubt that science education is a viable component of the academic community at Purdue University. The faculty have received over $800,000 in grants since 1977 from the National Science Foundation, the National Institute of Education, U.S. Office of Education, the Lilly Endowment Foundation, the Indiana Academy of Science, and the Alfred P. Sloan Foundation. In addition, each faculty member actively publishes. Members have been leaders in the Hoosier Association of Science Teachers, the Indiana Association of College Biology Teachers, the National Association for Research in Science Teaching, and the National Association of Biology Teachers. Within the university, their visibility is noted on the Teacher Education Council, committees within the academic departments, two chairpersons of undergraduate education, one chairperson of graduate education, one assistant dean in the School of Science, and three Fulbright-Hays awards. Many of these people contributed time and intellectual guidance to the project described.

Summary

The three-year special project described was the result of several cooperative relationships. In turn, it developed both inter- and intra-institutional as well as interpersonal cooperative activities. Funded by the National Institute of Education, the project was supported and sponsored by the Alabama Center for Higher Education, specifically by Miles, Stillman, and Talladega colleges and Alabama A&M University, and by Atlanta Junior College. The project was located at Purdue University where two schools – the School of Science and the School of Humanities, Social Science, and Education – provided space, staff, and support.

A myriad of experts – in editing, writing, research, statistics, use of libraries and computers, affirmative action, and many academic disciplines – interacted with the participants. All of these experts believed, as did the director, associate director, and staff, that excellence was obtainable. Together the participants and staff pursued excellence with vigor. The results of their pursuit are discussed in the remaining chapters of this book.

NOTES

1. National Research Centers: Center for the Study of Evaluation (CSE), University of California at Los Angeles; Research and Development Center for Teacher Education (RDCTE), University of Texas, Austin; Institute for Research on Educational Finance and Governance (IFG), Stanford University, Stanford, California; Learning Research and Development Center (LRDC), University of Pittsburgh; Center for Educational Policy and Management (CEPM), University of Oregon, Eugene; Center for Social Organization of Schools (CSOS), Johns Hopkins University, Baltimore; Wisconsin Research and Development Center for Individualized Schooling (WRDCIS), University of Wisconsin, Madison; National Center for Research on Vocational Education (NCRVE), Ohio State University, Columbus; National Center for Higher Education Management Systems (NCHEMS), University of Colorado, Boulder.

2. Science is used throughout this monograph to include natural and physical sciences, social and behavioral sciences, and mathematics. These areas are identified as science by the National Science Foundation.

3. The Alabama Center for Higher Education (ACHE) includes Alabama A&M University, Normal; Alabama State University, Montgomery; Miles College, Birmingham; Oakwood College, Huntsville; Stillman College, Tuscaloosa; Talladega College, Talladega; and Tuskegee Institute, Tuskegee.

4. Active participant denotes completion of research project. Attrition from the project is discussed in Chapter 2. Participants presented the following programs:

National Science Teachers Association, March 21, 1980

"The Effect of Specific Characteristics and Training on the Teaching Strategies of Minority Preservice Science Teachers."

Presider: Jane Butler Kahle, Departments of Biological Sciences and Education, Purdue University, West Lafayette, Indiana.

Presenters: Nell Anthony, Alabama A&M University, Huntsville, Alabama; Juanita Clarke, Miles College, Birmingham, Alabama; and Olivia Sanders, Alabama A&M University, Huntsville, Alabama.

National Association for Research in Science Teaching, April 12, 1980

"Factors Affecting the Achievement of Students in Black Southern Colleges."

Presider: Jane Butler Kahle, Departments of Biological Sciences and Education, Purdue University, West Lafayette, Indiana.

Presenters: Charlotte Carter, Miles College, Birmingham, Alabama; Mildred A. Collins, Stillman College, Tuscaloosa, Alabama; Barbara Small Morgan, Atlanta Jr. College, Atlanta, Georgia; Sandra E. Taylor, Talladega College, Talladega, Alabama; and Gwendolyn Wilson Davis, Talladega College, Talladega, Alabama.

REFERENCES

Alabama Center for Higher Education Bulletin. Birmingham, Alabama: Center for Higher Education.

Baker, G., and Hartley, J. "NIE Program Enhances Chances for Minorities and Women." *Comment* 11 (1979):3.

Fifth Report of the National Council on Educational Research, Fiscal Years 1978–1979. Washington, D.C.: U.S. Government Printing Office, 1981.

Grants for Research on Desegregation, Fiscal Year 1981. Washington, D.C.: National Institute of Education, 1981.

Kahle, J.B. "Advanced Study and Research Skills in Science Education for Women Faculty at Minority Institutions." Final Reports (NIE 780233). West Lafayette, Indiana: Purdue University, 1979, 1980, 1981.

Kahle, J.B. "A Case Study Report of the Science Education Program at Purdue University." In *Status Study of Graduate Science Education, 1960–1980.* NSF Contract 79-SP-0698. Iowa City: University of Iowa, 1980.

Kahle, J.B. "Enhancing the Research and Publication Productivity of Faculty Women." Paper presented at the American Educational Research Association Conference on Research on Women and Education, Pacific Grove, California, December 8, 1980.

Minorities and Women's Program, pamphlet. Washington, D.C.: National Institute of Education.

NIE Information, Winter 1980. Washington, D.C.: National Institute of Education, 1980.

The National Institute of Education, pamphlet. Washington, D.C.: National Institute of Education.

Schaffarzick, J., and Sykes, G. "A Changing NIE: New Leadership, A New Climate." *Educational Leadership* 35 (1978):367–372.

2 Women in Science and Science Education

The desirable qualities of faculty members are usually assessed under the heading of teaching, research, and service to the institution. Women's capacity either as teachers or contributing members of the research community has not been questioned, but their research potential has. —National Academy of Sciences, 1979, p. 82

Introduction

Before the request for proposals for the initial year of funding in the Minorities and Women's Program was released, Jane Butler Kahle had begun to wonder how to increase both the number and productivity of women in science and science education. Her background in guiding women graduate students as well as her experiences at professional meetings indicated that women did not have access to the avenues leading to success in academe with the accompanying rewards of status and salary. For example, during the 1978 annual meeting of the National Association for Research in Science Teaching, few papers were presented by women, yet a cadre of interested female researchers attended. Together they discussed mutual research problems and the possibility of joint proposals and projects. Shortly after this meeting, the request for proposals seemed to promise a solution for the dilemma. Funds were to be allocated specifically to enhance the research skills of women. Since research and publication provide a foundation for academic success, the Minorities and Women's Program might provide the necessary footholds so that women could successfully scale the "ivory tower."

Although definitive studies have not been done, observations indicate that a factor contributing to the lack of research and publication productivity by women faculty has been heavy teaching commitments. The National Academy of Sciences (1979) reports that within higher education, women doctoral scientists are more likely to teach than men. For example, almost 40% of women faculty have primarily teaching positions, while only 30% of male faculty members are classified as teaching staff (NAS, 1979). This situation is compounded by the fact that women are far more likely than men to be found in the lower ranks of academe. For example, the National Academy of Sciences (1979) reported that in 1977 46.5% of the positions classified as instructor/lecturer in the 25 institutions which received the most federal research and development funds were filled by women. In all other institutions of higher education, women held 26.8% of all such positions. Instructor/lecturer positions in academia are often teaching positions, used to staff service courses or to supervise laboratory instruction.[1] The academy notes that, in all cases surveyed, people in these positions are not allowed to seek outside research support. This restriction effectively eliminates any way to establish independent research records. Perhaps, because women "like to teach"; perhaps, because they are "socialized" that teaching is an acceptable occupation; perhaps, because they cannot get research positions—whatever the cause, the result has been disproportionate representation in the lower ranks of academe and heavy teaching loads.

The problem is compounded in science departments of many small colleges, where the lack of equipment and space also contribute to fewer research activities. Since the number of women faculty is inversely proportional to the size of institution, many women find themselves in smaller institutions, with less equipment and heavy teaching duties (NAS, 1979). The target population of this project was women faculty in science or science education at small, minority colleges. Therefore, they were encumbered with all the barriers to success mentioned above: they were women; they had heavy teaching-loads; they had little access to scientific equipment, graduate students, or libraries. Although only 10 participated in the project, they, and their situations, were representative of the least promising conditions for women in science and in science education. The intent of the project was to improve their status in academe by teaching them research skills in science education. If they could be taught to use their classrooms as their laboratories, research could be done. True, the nature of the research would change. Instead of investigating the structure of the cytoskeleton of the cell, for example, they would analyze factors affecting the learning of science by their students.

Training and Retention of Women Scientists

In the past, dire predictions often have been made about the number of women who complete baccalaureate and advanced degrees. These predictions have been based on social mores that discouraged the education of women and on the scarcity of suitable positions for educated women. Low predictions are no longer accurate due to changes in attitudes that have brought about a renaissance in women's education and in their participation in the work force.

Training of Women Scientists

The number of women enrolling in science has increased during the last 10 years. As Table 2.1 shows, in 1978 50% of all undergraduate enrollments in science were women. Women comprised nearly half of those enrolled in the biological sciences but lesser proportions in other sciences. To explain these increases, several researchers have examined factors affecting the choice of science by women. For example, Peng and Jaffe (1979) examined 16 variables in a study designed to identify multiple factors influencing the entry of women into male-dominated fields as they enter college. The data showed that high school course work, academic ability, success orientation, and educational plans were important predictors of women's entry into male-dominated fields. The results of this study indicated that women pursuing college degrees in male-dominated fields had higher academic ability and had more high school courses in science and mathematics. In addition, women who selected science majors were more career oriented than those selecting disciplines that were traditionally feminine such as social studies, the arts, and the humanities. These findings substantiated earlier ones by Erlick and LeBold (1977).

TABLE 2.1

Undergraduate Enrollments of Women by Field, Fall 1978

Field	Women Number	 Percent	Total Enrollment
Agriculture and Natural Resources	38,753	30	127,605
Biological Sciences	115,038	46	252,777
Engineering	49,742	11	451,160
Physical Sciences	32,720	26	123,986
All Fields	4,375,715	50	8,698,694

SOURCE: *Science Education Databook*, 1980, p. 35.

A comprehensive report sponsored by the National Academy of Sciences (1979) reiterates and documents these points. For example, this report states that "to the extent that grades and test scores are indicators of academic ability, women doctorates are a more promising group than men" (p. 25). The data presented show that approximately 7% of both male and female students have A to A + undergraduate grade point averages. However, almost 45% of women undergraduates carry grades A – to B +, while only 29% of male undergraduates maintain that average. However, the report documents a higher attrition rate for girls than boys from high school mathematics and science classes, concluding that ". . . thus the size of the pool of women with appropriate credentials for continuing to graduate science programs is considerably smaller than would be expected solely on the basis of academic ability and the range of courses available in secondary school and college" (NAS, 1979, p. 14). Other factors such as girls' perception of science as masculine and values of peer groups in coeducational high schools appear to limit the number of women prepared to enter science and mathematics.

Recently, Vockell and Lobonc (1981) studied the effect of a female's perception of a field as masculine or feminine on her academic and career choices. They also studied the effect of role models on career selection by high school girls. Their study was conducted in coeducational public schools and in girls' schools, run by religious orders. Interestingly, they did not find a positive effect due to the presence of a role model in either type of school. Girls who had and who had not had a woman science teacher selected science careers in about equal numbers.

In public schools, a significant correlation was found between the number of science courses taken, the level of success achieved in those courses, and the student's perception of the course. Females selected subjects traditionally viewed as "masculine" such as calculus, chemistry, and physics, less often than males; and in spite of equal abilities, they performed less well than their male peers. Concomitantly, fewer indicated an interest in "masculine" careers such as engineer, physicist, or mathematician. Other science areas traditionally are viewed as neutral; these include most areas and careers in the biological sciences. Girls in coeducational schools enrolled and performed well in biology courses and indicated strong desires for careers in the life sciences.

In single-sex schools, the above differences were not found. In an environment where they were not socially ostracized for success in a field perceived as masculine, girls enrolled and achieved in physical science and in mathematics as well as in the natural sciences. In addition, they indicated interest in a range of scientific and technical careers. The single-sex schools utilized were parochial schools, which attracted students for a variety of personal rather than academic reasons. Therefore, the authors ruled out the possibility that girls of this particular type of educational environment were more motivated.

Vockell and Lobonc's findings corroborate earlier studies indicating that women who receive B.A. degrees from women's colleges or from baccalaureate institutions with a long and continuous history of women graduates are more likely to pursue scientific doctorates (NAS, 1979). For example, almost 50% of the faculties of women's colleges are women. These institutions graduate about one-third of the women who go on to seek doctorates in science and engineering, although they produce less than 15% of all bachelor degrees awarded annually.

During the past decade, federal programs have sought to elucidate and to eliminate barriers to women in science. As Table 2.2 shows, the female percent of total degrees is at an all-time high in every science area at the bachelor and master's level. In addition, in 1976 women received a higher percentage of doctoral degrees in every science. The problem occurs when one goes beyond the rhetoric to the actual figures. Although Table 2.2 illustrates that the percentage of all degrees earned by women in the sciences and engineering has doubled since 1951, it is low in all areas. Furthermore, in 1976 approximately equal percentages of baccalaureate and master degrees were awarded to women. However, at the doctoral level, the percentages of women earning degrees in science dropped radically.

One factor that may contribute to the difference in the percentage of women and men completing doctorate degrees in science is financial support during their academic training. Although the National Academy of Sciences (1979) reports that men and women receive comparable amounts of graduate fellowships, there is a subtle difference. Men usually receive research assistantships, while women get more teaching fellowships. Teaching fellowships not only carry the message of lower status, but they also require that considerable energy and effort be diverted away from doctoral research. Research fellowships, on the other hand, allow the student to focus on scientific research.

Figure 2.1 shows that during the 1970s the percentage of doctorate degrees awarded to women finally reached a level comparable to the percentage awarded in the 1920s, the decade in which women struggled for the right to vote (Hartley, 1979). The women's movement of the 1970s contributed to the intellectual climate which resulted in doubling the number of doctorates in the physical and life sciences and quadrupling the number of women engineers at the doctorate level. Women now receive 13.5% of all doctorates awarded in science and engineering (NAS, 1979). This percentage compares favorably to the percentage (6.7%) received by women during the 1920s (NAS, 1979).

However, before citing these numbers in support of women's progress, consider the undergraduate pools available. Only about half as many women received bachelor degrees in the decade of the 1920s compared to the number receiving them in the 1970s. The ratio, then, of women doctorates to women baccalaureates in science has decreased; that is, although more women earn baccalaureate degrees in science, a smaller proportion go on to earn doctorates.

When the data base is broadened to include degrees in other areas, the number of women seeking advanced degrees is clearly higher in other areas. As Table 2.3 shows, women receive 33.3% of the doctorates awarded in education and 11.5% of those conferred in the social sciences. However, only at the master's degree level in education does the percentage of women receiving degrees approach their percentage in the population. This finding can be attributed to the large number of women in the teaching profession. Many states require master's degrees for continued teaching certification, and 57% of mas-

TABLE 2.2

Percent of Degrees Earned by Women, 1951-52 to 1975-76

	Year														
	1951-52			1957-58			1963-64			1969-70			1975-76		
Field	B.S.	M.S.	Ph.D.	B.S.	M.S.	Ph.D.	B.S.	M.S.	Ph.D.	B.S.	M.S.	Ph.D.	B.S.	M.S.	Ph.D.
Mathematics	28.1	17.3	5.3	28.4	19.4	6.1	32.0	19.1	4.7	37.4	29.6	7.8	40.7	34.0	11.0
Physics	4.7	4.0	1.9	4.4	3.1	1.9	4.7	3.6	1.4	6.1	7.1	2.6	10.9	9.1	4.5
Biological Sciences	26.0	17.3	11.0	22.0	21.8	12.3	28.1	28.8	11.9	27.8	31.5	14.3	34.6	31.7	21.5
Engineering	.2	.4	.7	.3	.3	.6	.4	.3	.4	.7	1.1	.7	3.1	3.6	2.3
Chemistry	16.0	11.9	4.4	18.6	9.7	5.2	19.5	17.6	7.2	17.9	22.4	7.7	22.4	21.1	12.1

SOURCE: *Science Education Databook*, 1980, p. 114, 117, 118.

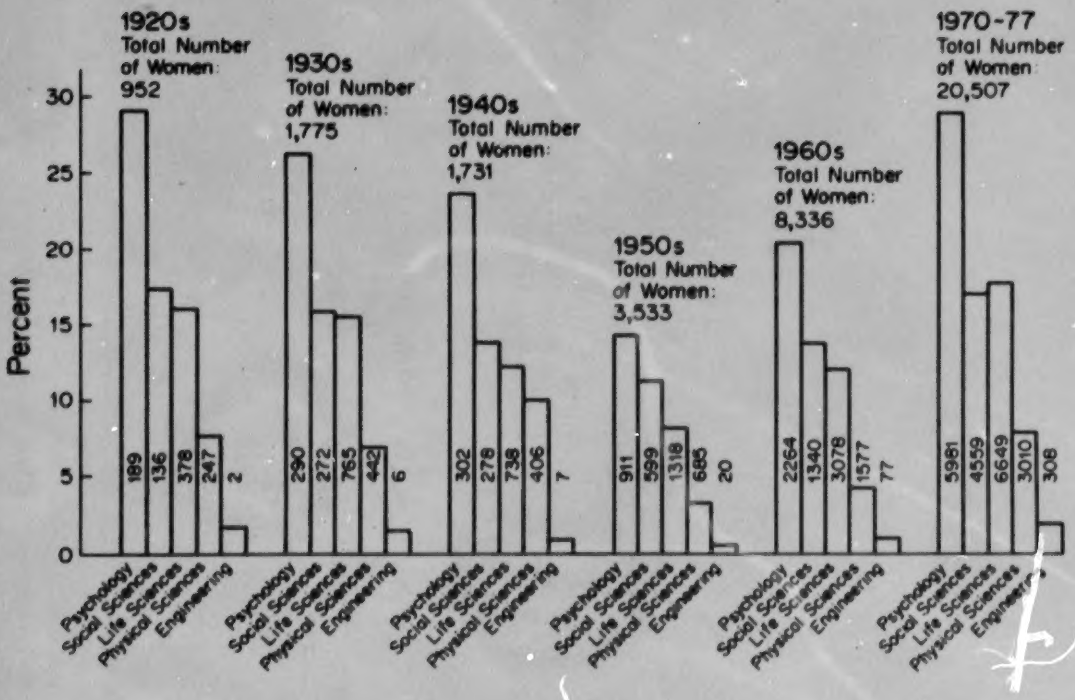


FIGURE 2.1

Percentage of Doctorates in Science Awarded to Women by Decade, 1920–1970

TABLE 2.3

Percentage* of Total Degrees Awarded to Women by Content Area in 1975-76

Content Area	Bachelor's	Master's	Doctorate
Education	26.8	57.0	33.3
Social Sciences	11.4	3.5	11.5
Biological Sciences	4.5	1.4	9.4
Physical Sciences	1.0	.6	3.8

SOURCE: *Science Education Databook*, 1980, p. 121.

$$\text{*Percentage} = \frac{\text{number of women enrolled in content area}}{\text{number of degrees earned by women in all fields}} \times 100$$

ter's degrees in education are awarded to women. The data for 1975-1976 are graphically displayed in Figure 2.2. In all areas, the percentage of doctoral and professional degrees continues to increase, although these percentages are far below the percentages of baccalaureate and master's degrees awarded to women, as shown in Figure 2.3.

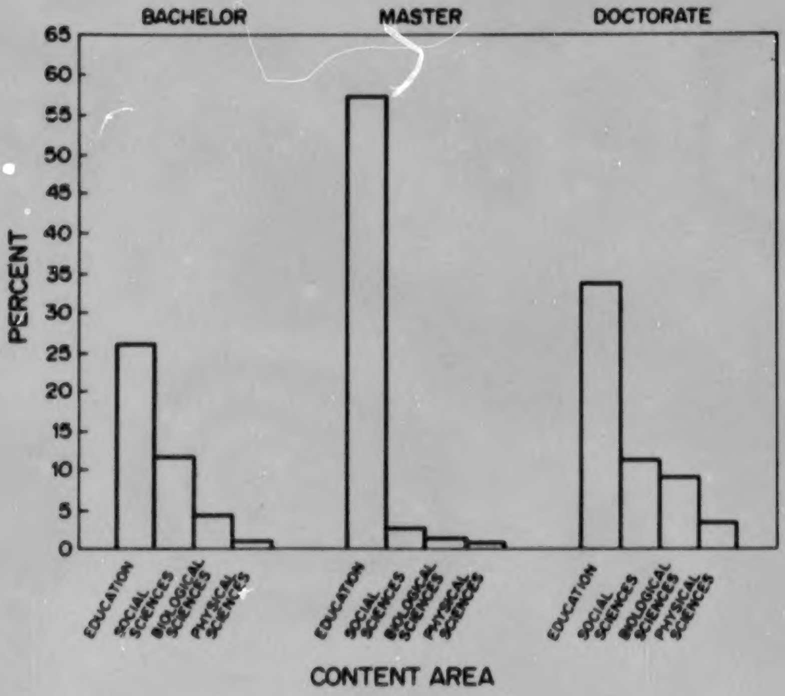
In summary, substantial numbers of women are now beginning to seek the training required to enter scientific and technological careers. The percentage of degrees awarded to women in science decreases from bachelor's to master's to doctor's degree. In biology, the content area most women select, these percentages fall from 34.6 to 31.7 to 21.5%. Biology, which is perceived as a neither masculine or feminine discipline, traditionally has attracted more women. However, the data presented in Table 2.1 is positive. This table, based on undergraduate enrollments in 1978, indicates that a sharp increase in the percentage of women trained in science may begin in 1982.

Retention of Women Scientists

Although entry numbers are important, the critical impasse has been the retention of women in science programs and later in scientific careers. In 1975, the National Science Board paid specific attention to the problems women encounter in various fields of the scientific enterprise. Its 1974 report showed that women constituted only 5% of those employed in science and engineering occupations. As Table 2.4 shows, in 1977 they composed almost 10% of the doctoral work force in all science and engineering fields. However, their partici-

FIGURE 2.2

Percentage* of Total Degrees Awarded to Women by Content Area in 1975-76



SOURCE: *Science Education Databook*, 1980, p. 121.

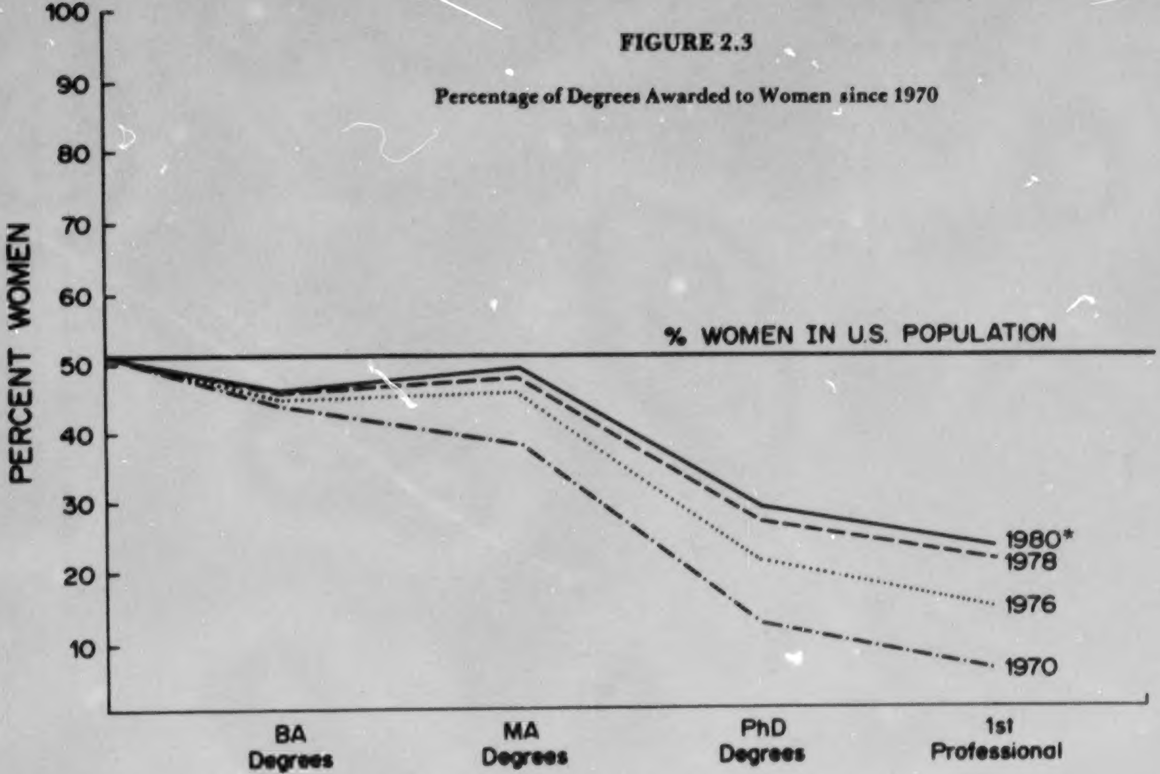
*Percentage = $\frac{\text{number of women enrolled in content area}}{\text{number of degrees earned by women in all fields}}$ × 100.

pation level varies from area to area, from almost 25% in psychology to less than 1% in engineering.

Though women comprise an increasing proportion of the scientific work force, they account for almost 30% of either unemployed or part-time employees among the pool of science and engineering doctorates. Again, the problem varies by field, with women in physics having the highest unemploy-

FIGURE 2.3

Percentage of Degrees Awarded to Women since 1970



SOURCES: *Condition of Education*, 1978, p. 138; *Condition of Education*, 1980, p. 128.
*1980 values are projected numbers.

TABLE 2.4

Number and Percent of Women Doctoral Scientists and Engineers in the Labor Force by Field, 1977

Field of Doctorate	Number of Women	Percent of Women
All Science and Engineering Fields	27,282	9.7
Math/Computer Sciences	1,151	6.9
Physics/Astronomy	646	2.5
Chemistry	2,551	6.1
Earth Sciences	332	3.6
Engineering	231	0.5
Life Sciences		
Agricultural	261	2.0
Medical	1,018	13.3
Biological	7,742	15.6
Psychology	7,543	23.1
Social Sciences	5,807	14.0

SOURCE: *Climbing the Academic Ladder: Doctoral Women Scientists in Academe*, 1977, p. 33.

NOTE: The statistics in this table are weighted estimates derived from a sample survey of 65,000 Ph.D.'s in science and engineering. The estimates are subject to two types of error—sampling and nonsampling, (e.g., nonresponse bias).

ment rate; but, overall, three times as many women as men doctoral scientists are unemployed or seeking employment (NAS, 1979). For example, in 1977, 3.6% of women with doctoral degrees were unemployed compared to less than 1% of the men (Vetter, 1978). However, the findings of an 18-month study by the Scientific Manpower Commission concerning number of women scientists and engineers in the labor force showed that the higher the educational credentials, the more likely women are to be in the labor force (Vetter, 1980). The results of this study, displayed in Table 2.5, indicate that a high percentage of women who major in science or engineering are in the labor force and that the percentage increases with each degree level. Other findings of the study are that level of graduate student support, highest degree obtained, presence and age of children, and field of degree are all factors affecting the number of women in the labor force. Marriage, on the other hand, appeared not to be a factor affecting employment by women in this study. Cole (1981), however, has not found that any of these factors, except families with more than three children, affect the research productivity of women scientists.

TABLE 2.5

Percentage of Women Scientists and Engineers in the Labor Force by Degree Level, 1975–78

Data Source	Year of Survey	Degree (%)		
		Bachelor's	Master's	Doctorate
A*	1976	83.6	87.5	
B*(1976)	1978	84.3	87.2	
B*(1972)	1978	79.9	86.5	
C	1975	63.1		
D	1978	71.0	78.1	96.1
E*	1977			89.5
F	1976	89.0	84.4	92.8

SOURCE: *Science*, January 4, 1980, p. 29.

KEY: A = Bachelor and master's graduates of 1974 and 1975; B = Bachelor and master's graduates of 1972 and 1976; C = Graduates from a 1961 entering class who received bachelor's degrees on or before 1971; D = Graduates from 1962 to 1977 in chemistry and engineering from 10 colleges and universities; E = Doctorate degrees earned in science and engineering in 1977; F = Science and engineering professionals with more than two years professional experience; * = Weighted sample.

The National Academy of Sciences (1979) also reports on factors affecting the retention of women in scientific careers. It reports contradictory findings indicating that marriage has often been used as a convenient explanation of a high attrition rate by women rather than citing more discriminatory factors such as underemployment and lower pay. As Table 2.6 shows, women doctorates in science and engineering are consistently paid less than male doctorates in all occupations, and from 1973 to 1977 the degree of underpayment did not improve. Although current data indicate that entry-level female engineers are paid slightly more than their male counterparts, it is the only field of improvement and of equity (Vetter, 1980).

In summary, women's progress in employment and advancement in scientific careers has not measured up to their educational advances. Although the proportion of earned degrees in the sciences and engineering has increased since 1950, the number of women in scientific careers has not improved accordingly. Personal and social factors, such as marriage and child raising, are of far less importance than factors directly related to characteristics of employment in preventing full participation of women in scientific careers. More women with doctorates in science and engineering are underemployed, unemployed, or lower paid than their male counterparts.

Women in Science in Academe

Since the minorities and women's project at Purdue University involved women in scientific disciplines at academic institutions, a survey of women in academe also indicated factors affecting their status and success. Among doctoral scientists, a higher proportion of women than men are employed in higher education (61% women, 55% men). In business and industry, the reverse is true (12% women, 28% men) (NAS, 1979, p. 58).

Women Faculty

Within academe, women hold vastly more positions in the lower, untenured ranks. For example, although women hold one in four full-time faculty positions, they account for only one in five tenured positions (NSF, 1980). Of more concern is the finding reported in the National Academy of Sciences' report (1979) that there continues to be a lag in the granting of tenure to women. Women proceed slower through the academic ranks at all institutions and fewer of them are granted tenure (Cole, 1981). As Table 2.7 illustrates, nationally women hold about 10% of full professor academic year appointments. However during the 1979–1980 academic year, roughly one-half of all lecturer and instructor positions were filled by women. In addition, the lower the percentage of women in the top ranks, the greater the "prestige" of the institution.[2] That is, when the data are analyzed by type of institution, women comprise less than 10% of the faculty at the top 25 institutions, 13% at the second 25 institutions, and 16% of full professors at other institutions (NAS, 1979).

The large number of women in the lower ranks as well as salary differences are indications that women have not progressed as rapidly as their male colleagues in academe. When average salaries, reported in Table 2.8, are converted to percentages, the following discrepancies are found. At all ranks, male faculty members employed under 12-month contracts at all public and private institutions of higher education earn over 36% more than female faculty members employed under similar circumstances. At the full professor rank, male faculty members under 12-month contracts at all public and private institutions earn 16% more than females similarly employed. When salaries are reported by field, women in some areas of science suffer larger percentage and dollar differences. For example, in 1977 women were paid proportionately less in chemistry and psychology than they were in 1973 (NAS, 1979). The existence of lower pay and status for academic women with comparable qualifications is an important reason why special programs to increase their productivity are needed.

TABLE 2.6

Median Annual Salaries of Doctoral Scientists and Engineers by Field and Sex, 1973 and 1977

Field	1973 Total	1973 Sex Men	1973 Sex Women	1977 Total	1977 Sex Men	1977 Sex Women
All Fields	$20,900	$21,200	$17,600	$25,600	$26,000	$20,700
Physical Scientists	21,200	21,400	17,400	26,600	26,800	21,200
Chemists	21,300	21,400	17,300	26,600	27,000	20,900
Physicists and Astronomers	21,100	21,200	17,700	26,500	26,600	23,100
Mathematical Scientists	19,300	19,400	17,100	23,300	23,600	19,900
Mathematicians	19,100	19,300	16,800	23,100	23,400	19,900
Statisticians	20,800	20,800	19,500	25,100	25,400	19,800
Computer Specialists	22,100	22,300	17,700	25,800	26,100	20,800
Environmental Scientists	20,700	20,900	17,000	25,800	26,000	19,700
Earth Scientists	20,700	20,800	16,700	25,900	26,000	20,000
Oceanographers	19,400	19,500	–	24,100	24,400	19,200
Atmospheric Scientists	22,800	22,800	–	28,300	28,900	19,200

Engineers	22,500	22,500	19,600	28,600	28,700	22,900
Life Scientists	20,000	20,400	17,300	24,700	25,100	21,000
Biological Scientists	19,500	19,900	17,100	23,800	24,300	20,500
Agricultural Scientists	19,800	19,800	–	24,800	24,900	20,200
Medical Scientists	23,000	23,500	18,300	28,000	28,900	22,800
Psychologists	20,200	20,800	18,200	24,100	24,900	20,600
Social Scientists	20,400	20,800	17,600	24,100	24,700	20,200
Economists	22,300	22,500	19,300	27,000	27,500	23,600
Sociologists/Anthropologists	19,500	20,200	17,100	22,200	22,900	19,700
Other Social Scientists	19,600	19,900	17,400	23,200	23,900	19,800

SOURCE: *Science Education Databook*, 1980, p. 142.

NOTE: All median salaries were computed only for full-time employed civilians. No median was computed for groups with fewer than 20 individuals reporting salary.

TABLE 2.7

Women as Percentage of Total Full-Time Faculty Members, 1979–80

	Professors		Associate Professors		Assistant Professors		Instructors		Lecturers		All Ranks	
	9-mo.	12-mo.	9-mo.	12-mo.	9-mo.	12-mo.	9-mo.	12-mo.	9-mo.	12-mo.	9-mo.	12-mo.
Private Institutions												
Universities	6.0	6.8	16.6	22.7	30.0	35.5	48.6	71.4	42.1	43.9	18.2	26.5
Other 4-Year	12.7	10.1	21.6	21.2	35.4	32.8	51.0	46.0	49.9	73.7	27.4	26.9
2-Year	29.6	23.3	42.7	32.5	52.9	39.8	57.4	53.8	—	—	48.6	41.3
Total	10.1	9.3	20.3	22.1	34.2	33.9	51.0	50.8	45.2	55.8	24.8	28.1
Public Institutions												
Universities	6.4	4.7	16.2	11.9	31.1	21.2	55.7	44.7	44.4	39.3	20.0	13.7
Other 4-Year	11.8	12.4	18.9	21.1	34.5	40.4	52.7	61.1	46.4	44.3	26.4	28.8
2-Year	23.5	17.8	29.4	30.6	38.6	41.6	47.7	47.3	46.1	47.4	34.7	36.1
Total	9.7	7.2	19.1	16.8	33.8	29.6	52.1	51.5	45.3	40.5	26.4	23.2
Public and Private Combined												
Universities	6.3	4.9	16.3	13.4	30.8	23.2	54.2	49.9	43.9	39.9	19.6	15.4
Other 4-Year	12.2	11.5	19.9	21.2	34.9	37.3	52.0	53.2	47.4	53.2	26.8	28.0
2-Year	23.8	18.4	29.9	30.8	39.3	41.4	48.4	48.9	47.4	47.4	35.2	36.6
Total	9.8	7.6	19.4	18.0	33.9	30.7	51.8	51.3	44.7	43.0	25.9	24.3

SOURCE: *The Chronicle of Higher Education*, Vol. 21, 1980, p. 8.

TABLE 2.8

Average Salaries of Full-Time Faculty Members, 1979–80

	Professors		Associate Professors		Assistant Professors		Instructors		Lecturers		All Ranks	
	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	Men	Women
Public and Private, 9-Month Contracts												
Universities	$30,561	$27,367	$22,386	$21,101	$18,210	$17,232	$14,272	$13,718	$16,327	$14,337	$24,423	$18,616
Other 4-Year	25,416	23,676	20,488	19,410	17,011	16,265	14,042	13,397	15,403	13,446	20,403	17,120
2-Year	24,031	22,961	20,862	20,334	17,665	17,009	15,570	14,224	15,940	13,423	20,765	18,672
Total	27,994	24,764	21,262	20,070	17,504	16,656	14,433	13,634	15,953	13,921	21,941	17,922
Public and Private, 12-Month Contracts												
Universities	$36,856	$34,072	$28,863	$26,579	$24,320	$22,113	$19,036	$16,752	$22,314	$19,305	$30,876	$23,203
Other 4-Year	31,759	27,965	26,149	23,494	21,164	19,330	15,763	15,042	17,630	15,426	25,240	19,371
2-Year	26,594	24,427	23,229	21,988	19,541	18,205	16,166	14,516	17,471	16,608	19,904	17,473
Total	34,896	30,190	27,421	24,459	22,771	20,233	16,716	15,328	21,339	18,173	27,039	19,816

SOURCE: *The Chronicle of Higher Education*, Vol. 21, 1980, p. 8.

TABLE 2.9

Women Chief Executive Officers in Colleges and Universities*

Type of Institution	Number of Women Chief Executive Officers																	
	Members of Religious Orders						Others							Combined Total				
	1975	1976	1977	1978	1979	1980	1975	1976	1977	1978	1979	1980	1975	1976	1977	1978	1979	1980
4-Year Private Colleges	79	83	82	75	82	80	19	24	25	39	38	44	98	107	107	114	120	124
2-Year Private Colleges	26	23	23	23	25	20	8	8	7	9	12	13	34	31	30	32	37	33
4-Year Public Colleges	0	0	0	0	0	0	5	3	5	9	14	21	5	3	5	9	14	21
2-Year Public Colleges	0	0	0	0	0	0	11	13	14	22	33	41	11	13	14	22	33	41
Total	105	106	105	98	107	100	43	48	51	79	97	119	148	154	156	177	204	219

SOURCES: *Comment*, January, 1981, p. 7; *Comment*, June, 1980, p. 9.

*Only women in institutions accredited by the major regional accrediting associations in the United States, Puerto Rico, and Guam (N = 2,765 in 1980; 2,722 in 1979).

Women Administrators

Women are not only underrepresented in high ranking faculty positions, but also, with a few notable exceptions, they are excluded from higher administrative ranks. When the number of female chief executive officers is tabulated, only 21 public four-year institutions had women presidents in 1980. However, as the data in Table 2.9 indicates, that was a significant increase over three women chief executive officers in 1976. Women fare better in private and church-related four-year colleges and in public two-year institutions. However, many of the former are women's colleges, and chief executives of the latter often have lower status. In all, out of the 2,765 chief executive positions included in the data for Table 2.9, women held 219 positions in 1980. When this data is converted to percentages, women held only 7% of the total chief executive positions in 1980, an increase of 1% since 1978.

Tidwell (1981) summarized a study by the American Association of University Women which described the status and role of women in academe. She compares the situation of women in 1981 to their status in 1970:

1. In 1981 only 25% of full-time faculty are women. These data indicate no change from 1970.
2. There is an inverse relationship between the number of women faculty and faculty rank: the higher the rank, the fewer the women. Nationally, in 1981, 28% of assistant professors, 16% of associate professors, and 8% of full professors are women.
3. Among the women employed as full-time faculty members, only 16.5% are tenured.
4. There is a negative correlation between the size of an institution and the number of women on its faculty. In colleges, and universities with enrollments of over 10,000, 22% of the faculty are women, while at schools with less than 1,000 students, 37% of faculty are women.
5. There is a negative correlation between the size of an institution and the proportion of women at higher faculty ranks. For example, at the smallest schools, women fill 23% of full professor positions, but only 7% of these positions at the largest institutions.
6. Women administrators generally hold middle- and low-level positions rather than the highest positions of president, chief academic officer, business officer, or development officer. As was found in 1967–1970, women are more likely to hold positions related to student services and external affairs.
7. Only 18% of college and university deans are women.
8. The proportion of women holding top-level administrative posts has increased slightly since 1970, but women are still underrepresented.

Although the increase in Ph.D women has led to an increase in their presence among science faculties, the gains in total positions, particularly in tenured positions are modest. In summary, women generally have lower academic ranks and are paid less than their male colleagues at each academic rank. Furthermore, they are underrepresented in administration. Though the gains in the last decade have been greater than earlier decades, they remain modest. In spite of federal edicts, women are still second-class citizens in higher education.

Minority Women

A careful search of current literature, including women studies, higher education, and other related topics, revealed a dearth of information regarding women in science and science education at southern minority colleges. Since the participants in this project were all minority women, an extensive search for literature pertaining to minority women was undertaken. Again, little was found. As noted in one survey, "Many research reports have been published in the 1970s under titles which include some variation on the phrase, 'the status of minorities and women.' In most cases, 'minorities' has meant white females. Minority women have been nearly invisible" (Strauss, 1979, p. 10).

The data available for higher education is reported in terms of minorities and women; no source was identified for minority women. For example, Corbitt (1978) reports few representatives of minorities hold positions in higher education. The National Center for Education Statistics (1978) cites national figures to indicate that both women and minorities are underrepresented in higher education and that most of them hold low status positions. Usually, the number of minorities decreases as rank increases, especially between the assistant professor and associate professor ranks, the level where advancement to tenured positions is most critical. This is the same pattern found for women; therefore, one can assume it holds for minority women.

An increased awareness of women's status in higher education is essential to an understanding of the roles minority women have in the academic environment. Recently, several conferences have examined the unique position of black minority women faculty and administrators. One of the first of these, held in 1975, was sponsored by the National Institute of Education. This conference was the first one in a series which addressed the educational and occupational needs of various ethnic and racial groups of women. According to its proceedings, the following conditions confront black women in or about to reenter academia:

1. Child care is not a major concern for either professional black women or reentry black women.
2. A significant number of black professional women are considered low achievers prior to returning to college.
3. A majority of the respondents receive psychological support from husbands or male friends.
4. Generally, college administrators and faculty members are insensitive to black women's reentry problems.
5. College administrators and faculty members appear to be both racist and sexist toward reentry black women.
6. Peers and black faculty provide the greatest support for reentry black women.
7. Counselors and white faculty provide the least services for reentry black women.
8. Tutorial programs provide little, if any, resources to implement reentry for black female students (Cossey and Toney, 1977, pp. 163-164).

From this analysis, some issues which have been identified as "women problems," such as child care and spouse encouragement, are not seen as crucial with black women reentering college. Critical concerns, however, include bureaucratic regulations, faculty and administrative encouragement, and academic resources.

A second conference examined the needs and concerns of black women administrators, both in academe and in professions. In 1980, the American Council of Education sponsored a Women Executive Seminar Series. This conference focused on the issues confronting women administrators, both in academe and in the business sector. The conferees identified several variables affecting their performance regardless of administrative setting. These included race, sex, and role. Many minority women administrators reported that their actual duties did not match their job descriptions. As one participant observed, "There are doubts about your abilities because you are a woman and because you are black or another minority" (*Comment, 12* 2 1980, p. 5). In addition, women minority administrators had to resolve differences between how they were perceived by others and how they saw themselves. For example, the black female vice-president of Portland State University explained that in addition to her administrative duties, she had to handle "everything concerned with minorities." In her opinion, this added responsibility interferred with her performance of other duties (*Comment, 12* 2 1980, p. 5).

The National Institute of Education is beginning to report data concerning the role and status of minority women in academia and in the professions, but little information is available now. Therefore, an analysis of minority participants in this project was conducted to reveal personal characteristics and professional goals of minority women in science and science education.

Project Participants

A positive step in achieving higher status for women in academe, specifically for women faculty members at southern minority institutions, was taken by the women who participated in the National Institute of Education's project at Purdue University. The activities of this project addressed many issues which affected the status of women faculty. Kahle identified the lack of scholarly research and publication productivity as critical factors; thus the project was designed so that the participants carried out the total research and dissemination process through their participation in two summer workshops at Purdue University and their interim research activities.

Figure 2.4 presents demographic data which describes the women who participated in the initial year of the project. Personal data shows that half of the participants were married, and six of the 10 had one or more dependents, either children or elderly relatives. Their median age was 42. Seven of the original 10 participants completed the project, and they are described in Appendix A. Two of the participants did not continue after the initial year because they had satisfied their personal career goals, while a third participant accepted a faculty position in Maine.

The women who applied to and were accepted by the project had attained moderate levels of professional success. For example, one had attained the rank of full professor and three had earned doctoral degrees in education.[3] The rest had earned master's degrees: one in mathematics, one in mathematics education, two in biology, two in science education, and one in sociology. Although only one had published more than one professional paper, all were active in professional organizations. Prior to the project, only one had attained an administrative position.

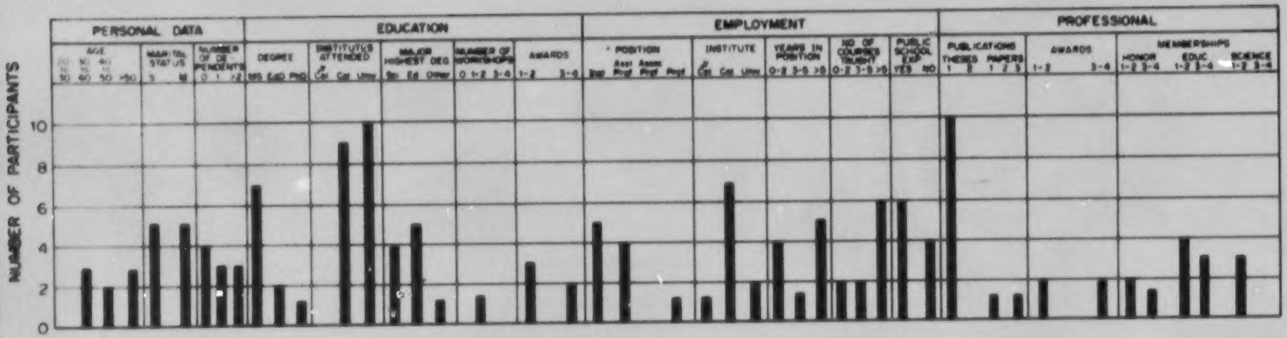
The NIE/Purdue University participants were dedicated teachers, who had an average of 4.3 different class preparations. Of the seven completing this project, three taught in science departments, one in mathematics, one in sociology, and two in education. In addition, each was involved with student activities on her home campus, sponsoring science clubs and science projects. Most were very active in campus church groups, choirs, and related activities.

Summary

Women in higher education have experienced personal and professional barriers which have limited their numbers in academic positions of authority and status. Changes in the 1970s have alleviated some of these barriers, thus increasing opportunities for women making them somewhat more equitable

FIGURE 2.4

Demographic Data, Selected Women Faculty at Minority Institutions



with opportunities for men. However, the number of women in the professional work force does not reflect the number of women who have received appropriate training.

The NIE/Purdue University project was designed to alleviate barriers to women faculty at minority institutions. Collaborative efforts were directed toward improving research and writing skills and toward providing strong role models and mentor relationships. These efforts were intended to increase retention, to maximize participation, and to augment advancement of these women in academe.

NOTES

[1] Service course indicates a basic science course, staffed by a science department, but offered to nonscience majors.

[2] "Prestige" indicates ranking of institutions based on amount of federal research and development monies allocated. Institutions are grouped as the top 25, second 25, and other.

[3] The earned doctorates of the project's participants were: one Ph.D. in Counseling Education, one Ed.D. in Secondary Education, and one Ed.D. in Elementary Education.

REFERENCES

"American Council on Education Program Opens Professional Networks of Higher Education to Women Administrators." *Comment 12* 3 (1981):7.

Cole, J.R. "Women in Science." *American Scientist* 69 (1981):385–392.

Corbitt, G. *Availability Data in Academic Professions and Related Occupations.* 2nd ed. Boulder, Colorado: Affirmative Action Office, 1978.

Cossey, B.A., and Toney, G.O. "Baseline Data on Mid-Career Change and Re-entry for Black Women." In *Conference on the Educational and Occupational Needs of Black Women Compendium 2.* Washington, D.C.: National Institute of Education, 1977.

Erlick, A.C., and LeBold, W.K. *Factors Influencing the Science Career Plans of Women and Minorities.* West Lafayette, Indiana: Purdue Research Foundation, 1977.

Escobedo, T.H. "Predoctoral Collaboration Efforts to Increase Participation of Minorities and Women in Educational Research" *Journal of Educational Equity and Leadership.* 1 (1981):98–109.

Hartley, J. "Increasing the Participation of Women in Scientific Research." *Comment 11* 1 (1979):1.

Magarrel, J. "More Women on Faculties; Pay Still Lags." *Chronicle of Higher Education 21* 6 (1980):8.

Maxwell, G.; Rosenfeld, R.; and Spilerman, S. "Geographic Constraints on Women's Careers in Academia." *Science* 204 (1979):1225–1231.

"Minority Women Administrators Discuss Major Concerns in Higher Education." *Comment 12* 2 (1980):4–5

Miranda, L., *et. al. A Literature Review to the National Institute of Education, 400-79-0011.* Program to Increase the Participation of Minorities and Women in Educational Research. Washington, D.C.: National Institute of Education, 1979.

National Academy of Sciences (NAS). *Climbing the Academic Ladder: Doctoral Women Scientists in Academe.* Washington, D.C.: National Academy of Sciences, 1979.

National Center for Education Statistics. *The Condition of Education.* NCES-78-405. Washington, D.C.: U.S. Department of Education, 1978.

National Research Council (NRC). *Science, Engineering, and Humanities Doctorates in the United States, 1977 Profile.* Washington, D.C.: National Academy of Sciences, 1978.

National Science Foundation (NSF). *Science Education Databook.* SE-80-3. Washington, D.C.: National Science Foundation, 1980.

National Science Foundation and Department of Education (NSF/DOE). *Science and Engineering: Education for the 1980s and Beyond.* NSF-80-78. Washington, D.C.: National Science Foundation, 1980.

"On Campus with Women." *Project on the Status and Education of Women,* Association of American Colleges. 30:3-16. Washington, D.C. Spring 1981.

Paldy, L.S. "The Advancement of Women in Scientific Careers." *Journal of College Science Teaching* 8 (1978):48–53.

Peng, S.S., and Jaffe, J. "Women Who Enter Male-Dominated Fields of Study in Higher Education." *American Educational Research* 16 (1979):285–293.

"Re-entry Women: Special Programs for Special Populations." Field Evaluation Draft, Project on the Status and Education of Women. Washington, D.C.: Association of American Colleges, 1981.

"Re-entry Women: Relevant Statistics." Field Evaluation Draft, Project on the Status and Education of Women. Washington, D.C.: Association of American Colleges, 1981.

Solomon, L.; Bisconti, A.; and Ochsner, N. *College as a Training Ground for Jobs.* New York: Praeger, 1977.

Stage, E.K. "Retaining Women in Sciences: Research Bibliography." Paper presented at the National Association for Research in Science Teaching, Boston, April 12, 1980.

Strauss, M.J. "Minority Women in the United States." *Comment 11* 2 (1979):10–11.

Tidwell, R. "University Efforts to Promote Minorities and Women: Three Realities." *Journal of Educational Equity and Leadership* 1 (1981):115–125.

Vetter, B. "New Data Show Uneven Progress for Women and Minorities in Science." *Science* 202 (1978):507–508.

Vetter, B. "Working Women Scientists and Engineers." *Science* 207 (1980):27–34.

Vockell, E.L., and Lobonc, S. "Sex-Role Stereotyping by High School Females in Science." *Journal of Research in Science Teaching* 18 (1981):209–219.

Wallace, P.A. *Black Women in the Labor Force.* Cambridge, Massachusetts: Unpublished paper, Massachusetts Institute of Technology, 1980.

Wertheimer, B., and Nelson, A. "Into the Mainstream: Equal Educational Opportunity for Working Women." *Journal of Research and Development in Education* 10 (1977):61–76.

3 Minority Science Education

. . . Black colleges, still today, are the main centers for providing upward mobility for blacks. Many of the students that these institutions admit are the first of their families to attend college. Many still enter college with academic deficiencies and are in need of other kinds of support for successful college achievement. Many are from poor families. Studies related to higher education participation indicate low correlations between higher education participation and each of the variables cited here. Yet, black colleges graduate over fifty percent of the black students who receive baccalaureate degrees each year. . . . Even more impressive is the fact that of the blacks who hold the highest academic degree, the Ph.D., over seventy percent earned their baccalaureate degrees from black colleges. Indeed, black colleges are vital resources to our nation. – W.C. Williams, 1981, p. 3

Introduction

Few argue the important influence and impact that traditional black liberal arts colleges have had on minority education. W.C. Williams, president of Miles College, states above how well these colleges serve minority students. Furthermore, 76% of all black lawyers, 90% of all black teachers and social workers, and 75% to 80% of all black doctors and dentists received their bachelor degrees from historically black institutions (Thomas, 1980). Yet their continued growth and development is questioned. For example, Williams (1981) thinks that their very existence is threatened by the Department of Education's civil rights legislation. Indeed, if they are to survive and flourish, problems with financing, enrollments, financial aid, and accreditation must be met.

Minority Institutions of Higher Education

The accessibility of higher education for minority students was minimal until the late 1800s. The few blacks who gained entrance into institutions of higher education often had to leave due to financial or personal constraints and, therefore, were unable to complete their degree requirements. Many more were simply refused entrance. However, by the turn of the century over 2,000 blacks had graduated from American colleges, and the majority of them had attended traditionally black colleges in the southern part of the United States.

Finances

Since most blacks lived in the South during the 19th century, the refusal of state governments to contribute public funds to minority institutions severely restricted higher education for minority students. The Morrill Act of 1862, establishing land grant colleges, was the first provision of support which included minority institutions. However, many southern states chose to appropriate Morrill funds exclusively to land-grant colleges for majority students. It was not until the second Morrill Act of 1890, which restricted appropriations unless the proceeds were divided among institutions serving all races, that equitable support was available for some minority institutions.

To overcome financial difficulties, northern missionary groups and southern black church groups worked cooperatively to build facilities, to hire teaching personnel, and to establish private colleges open to the indigent of all races. Two black colleges, Tuskegee Institute and Hamilton Institute, benefitted greatly from early contributions. Many believed monies were awarded to these institutions because their curricula had an industrial, rather than a liberal arts, focus.

Recent efforts to improve education for black students have centered primarily on more and new sources of financial support. Monies have been solicited from the private sector as well as from state and federal agencies. One way small colleges can operate more economically is by forming consortia. A consortium of colleges in Alabama, the Alabama Center for Higher Education (ACHE), has dealt with the financial problems of its member institutions by soliciting funds from both the public and private sector, as shown in Table 3.1.

Enrollment

Black institutions, both undergraduate and graduate, have suffered a decrease in enrollment in recent years. In the 1900s, 96% of all blacks attending colleges or universities, were enrolled in minority institutions; today less than 20% choose these institutions. The institutions most affected are the traditional

TABLE 3.1

Sources of Funding for ACHE Operations Initiated between 1971 and 1976

Year of Funding Initiation					
1971–72		1973–74		1975–76	
Source	*Amount*	*Source*	*Amount*	*Source*	*Amount*
Alabama Council on the Arts	$ 10,200	CETA: Title II	$ 86,000	Alabama Commission on Aging	$ 29,000
Carnegie Corporation	357,000	Member Institutions	40,000	Alabama Committee for the Humanities and Public Policy	18,000
Emergency School Assistance Program	78,400	National Endowment for the Humanities	189,000		
		USOE: Title III	320,000		
Ford Foundation	105,000			CETA: Title I	108,000
		Special Programs for Disadvantaged Students	285,000		
Member Institutions	110,000			Community Service Administration	31,000
Rehabilitation Services Administration	26,000				
				National Endowment for the Humanities	89,000

Southern Education Foundation	1,000			Southern Education Foundation	5,000
Title V-E: Education Professions Development Act	138,000			The Rockefeller Foundation	171,300
USOE: Cooperative Education	70,000			USOE: Title III	256,000
				Ethnic Heritage Studies	175,000
Total	$895,000	**Total**	$920,000	**Total**	$882,300

SOURCE: *Alabama Center for Higher Education Bulletin.*

black colleges and universities located in the southern region of the United States. As Black has stated, "Alabama's traditionally black colleges are struggling again — this time to keep up their enrollment as more black students leave high school and head for junior colleges or the larger white universities" (1980, p. 6A). Table 3.2 shows the enrollment trends from 1969 to 1979 of the institutions that participated in this project. Two historically black institutions, Miles and Stillman Colleges, have experienced a slight, but steady, decrease in enrollment, while Talladega College, a similar institution, has not. According to the participants, Talladega College continues to provide liberal arts education for some of the most able black students. Although Alabama A&M University appears to have quadrupled its enrollment, the inclusion of graduate students from 1976 on has confounded the data. Most of the participating colleges have prevented drastic enrollment declines by adapting "open-admission"[1] policies.

TABLE 3.2

Enrollment Trends of Participating Four-Year Colleges and Universities

Institution	1969	1976	1978	1979
Alabama A&M	1,702	4,564	4,463	4,500
Stillman	648	857	838	700
Talladega	426	625	650	712
Miles	NA	1,472	1,386	1,058

SOURCE: *The Birmingham News*, August 7, 1980, p. 1.

KEY: NA = Data not available.

As federal legislation continues to open up opportunities for blacks in higher education, adequate financial aid has replaced admission as the primary concern of black students. Since many minority students come from low socioeconomic backgrounds, financial aid funds frequently do not cover the costs of their higher education. The National Board on Graduate Education reported in 1974–1975 that black and Hispanic college-bound high school seniors estimated that their parents could contribute about $200 toward college expenses, the median figure estimated by white students was over $1,000 (*Minority Group Participation in Graduate Education*, 1976). Although sufficient financial assistance does not insure a successful college career, it may be the major inhibiting factor for many minority students. Financial aid programs at the participating colleges are shown in Figure 1.5. All of these institutions have varied student aid programs which also may have helped them maintain enrollments.

Accreditation

From 1900 to 1960, enrollments generally increased in historically black institutions. However, facilities and services often could not keep pace. For example, library, laboratory, and classroom buildings were often inadequate. The lack of these resources was a factor in denying accreditation to black colleges. In the 1900s the Southern Association of Colleges and Secondary Schools devised a new category in which to admit minority institutions. The new category, "approved" rather than "accredited," implied different accreditation standards for colleges serving minority and majority students. Black colleges such as the ones participating in this project could not become fully accredited and equal members of the Southern Association of Colleges and Secondary Schools until 1930. As discussed in Chapter 1 all institutions participating in this project are accredited.

In summary, although it is not the intention of this work to describe the many factors affecting minority institutions of higher education, some of the main ones—financing, enrollments, and accreditation—must be considered. Many people believe that the existence of historically black institutions of higher education is threatened by the accessibility of majority education. However, the enormous contribution of these institutions has done much to mold the history of a race and of our nation. Efforts should be made to ensure their continuation.

Minority Science Education

As we develop into a technocratic society, education in the sciences and in mathematics becomes a paramount concern. Yet, overwhelming evidence exists that minorities, particularly blacks, and women are underrepresented in science courses and, subsequently, in science careers. Although societal, personal, and educational factors contribute to this underrepresentation, we will consider only the educational ones. Since most students follow identical programs through elementary and junior high school, differences in scientific training do not appear until high school. We shall examine educational factors which limit minority participation in science by analyzing secondary schools. Next, the contributions of minority institutions toward undergraduate and graduate science education will be assessed.

Secondary Schools

> In these days, it is doubtful that any child may reasonably be expected to succeed in life if he [sic] is denied the opportunity of an education. Such an opportunity, where the State has undertaken to provide it, is a right which must be made available to all on equal terms. ("Brown v. Board of Education" in *Toward Equal Educational Opportunity*, 1974, p. 20)

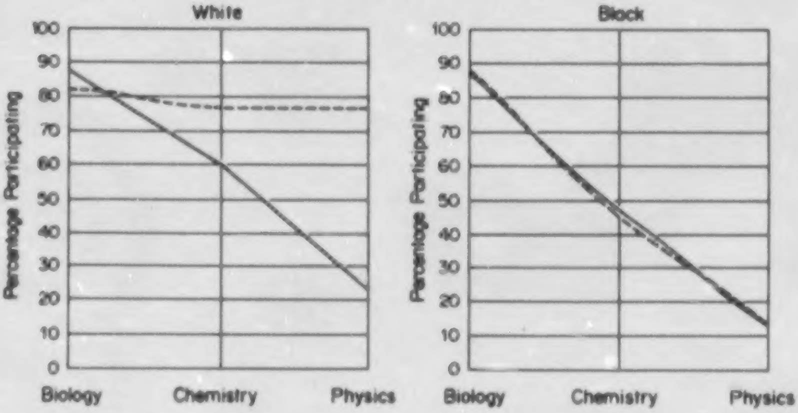
A quarter of a century has passed since the Supreme Court in 1954 declared unconstitutional "separate, but equal" schools. This decision stated that segregated schools were illegal, yet many examples exist of both formal and informal segregation by school and by classroom, by tracking and by counseling, by choice and by ignorance. Kahle (1979) has reported that National Assessment data (NAEP, 1979) indicate that in the Southeast approximately 30% of the black 9-year-olds, 39% of the black 13-year-olds, and 47% of the black 17-year-olds attend schools that are 60-100% white. Between 20% and 30% of blacks in each age group attend schools with a majority of white students in the northeast, central, and western regions of our country. Despite this evidence of partial integration of the nation's schools, the effects of continued segregation remain today. As Stake and Easley (1978) suggested, the problem is multifaceted: "It is not the fiscal provisions that concern us here but the more fundamental differences in opportunity to learn, involving the competence of the teacher, the quality of the learning materials, the learning place(s), the peer group of students engaged in learning" (p. 14:11).

The effects of segregation on the attitudes and achievements of minorities does not stop at the school level; thousands of classrooms are segregated, either by formal or informal procedures. These practices result in fewer opportunities open to minority students, and they are especially damaging in science and mathematics where each course builds upon earlier content. The disparity between black and white students in high school science classes is shown in Figure 3.1. Formal methods of segregating classrooms usually involve either "tracking" or "grouping" of students by ability, by occupational intention, or by prerequisite. Tracking denotes the long-term assignment of students into different groups taught with different long-term objectives and with little provision for, or expectation of, reassignment. This practice was declared unconstitutional in 1967, yet three recent national surveys of science education report instances of it (Stake and Easley, 1978; Helgeson, Blosser, and Howe, 1978; Weiss, 1978).

Although grouping denotes more flexibility and temporary assignments, in practice few reassignments occur (Stake and Easley, 1978). Furthermore, grouping often results in segregated classrooms in desegregated schools. Con-

FIGURE 3.1

Comparison of Majority and Minority Enrollments in High School Science Courses



SOURCE: *The Physics Teacher,* May, 1978, p. 281.
KEY: _____ Female college freshmen
_ _ _ Male college freshmen

sider the following description of two types of math classes in a California school (Stake and Easley, 1978: 14:17, 18).

Number of Students in Different Classes

	White	*Oriental*	*Black*	*Hispanic*
Advanced Math	15	3	0	0
General Math	10	0	8	8

Furthermore, they report that over 60% of the students in the lowest level of science classes in a Texas school were black males, assigned first because of a reading problem, second because of a math problem, third because of a discipline problem, and last because of a science problem (Stake and Easley, 1978). This second type of segregation, within the classroom, affects attitudes toward science and achievement in science in much the same way school segregation has in the past.

Classrooms are also informally segregated by the requirement of prerequisite classes. Many minorities do not take science courses because they have not been counseled into the academic "tracks" or into the prerequisite mathematics courses (Shorter, 1979). For example, Ignatz (1975) reports an alarming underrepresentation of blacks in advanced science classes in a large sample of students in Florida. His data, presented in Table 3.3, shows that although enrollment of blacks in Biology II is similar to their percentage of the total enrollment, blacks are noticeably underrepresented in the physical science classes listed. Lack of enrollment in these courses and in higher mathematics courses effectively eliminates minority students from science majors and science careers. Indeed, the doors are shut before they can be opened.

TABLE 3.3

Percentage by Race Enrolled in Science Courses in 44 Public High Schools in Northern Florida*

Course	Black	White
Biology II	23	77
Chemistry I	9	91
Chemistry II	6	94
Physics I	7	93
Other	29	71

SOURCE: *Science Education*, 1975, p. 571-573.

*Total enrollment: 28,121 of which 75.2% were white and 24.8% were black.

It is evident that many gifted young people are undertrained and underutilized in the sciences and in mathematics. In 1979, the National Research Council (1979) noted that a large fraction of the nation's corporate executives and half of the federal decision-makers come from science and engineering backgrounds. The report goes on to state that as children approach adolescence, the availability of role models becomes an important factor in their selection of future careers. Mary Budd Rowe (1977) also cites this as a possible reason why blacks choose fields other than the sciences. Studies have shown that, although parents are listed by adolescents as the individuals most responsible for their career choices, associations with other adults holding specific occupations are second in importance (Pallone, Hurley, and Richard, 1973). There is a need, therefore, to provide minorities with more minority role models within science and mathematics by increasing the number of members of minorities teaching science and mathematics during the critical years (ages 14–17).

Many of the participants in this grant were role models for both pre- and inservice secondary teachers. The project's attempts to inform them of relevant research, to assist them in forming supportive networks, and to analyze the educational needs of their students may enhance their future roles in science education.

Colleges

There is a recognized need for recruitment of minorities into scientific and mathematical fields and courses. As Rowe (1977) has stated, "The National Academy of Sciences (NAS) Committee on Engineering reports that blacks continue to be markedly under-represented among students in these fields" (p. 34). She also noted that ". . . middle-class blacks are choosing to enter politics, law and other social sciences, but not the research sciences or engineering. Even when blacks are successfully recruited as science students, their drop-out rate is high and they frequently ask to change profession enroute" (p. 34).

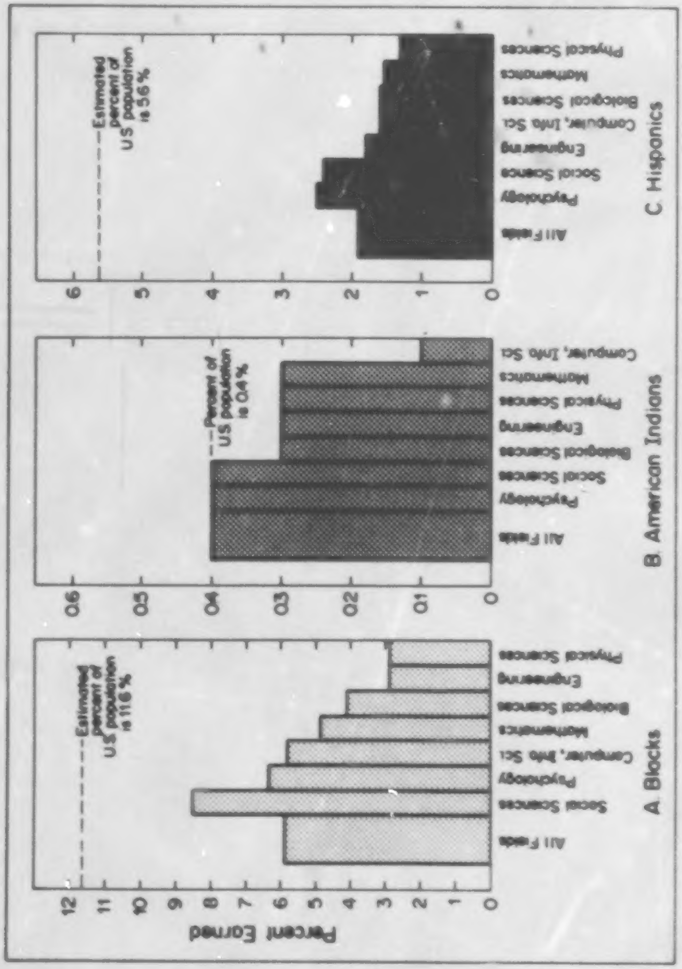
In order to evaluate the participation of the black segment of our population in science courses and careers, analyses of other minority groups is appropriate. Among the four generally identified minority groups, persons of Asian origin are overrepresented in the sciences and engineering; while the other three groups, American Indian/Alaskan native, blacks, and Hispanics, are underrepresented, as shown in Figure 3.2. Of these three groups, blacks make up the most significant proportion of our population; they compose 15% of the 18-21-year-olds and 10.7% of the total undergraduate population. However, blacks account for only 6.9% of undergraduates majoring in the biological sciences, 5.9% in engineering and 4.6% of physical science majors (Office of Civil Rights, 1976).

At the graduate school level, the number of blacks receiving doctorates in scientific disciplines is even lower. In 1977, they constituted less than 4% of Ph.D. recipients in all science and engineering fields. Table 3.4 presents data concerning the percentage of degrees awarded to minorities in physical science, biological sciences, and social science. These data illustrate the dearth of blacks receiving baccalaureate, master, and doctoral degrees in science. When data concerning percentages of degrees awarded to blacks in these three areas, along with education, is graphed, as in Figure 3.3 the disparity at advanced-degree levels is startling. For example, for blacks to reach population equity in the percentage of degrees awarded in physical science, approximately a 700% increase in number of doctoral degrees is required (*Minority Group Participation in Graduate Education*, 1976).

Qualifications for graduate study may be achieved by attending either majority or minority institutions. However, the attrition rate of black graduate students is notably high. Factors such as "motivation, persistence, and compatability with departmental expectations and resources" influence whether or not

FIGURE 3.2

Percent of Bachelor's Degrees in Science Earned by Minorities by Field, 1975–76



SOURCE: *Science Education Databook*, 1980, p. 120.

*Figures for the black and Hispanic populations are from the March, 1978 *Current Population Survey* and, therefore, are estimates.

TABLE 3.4

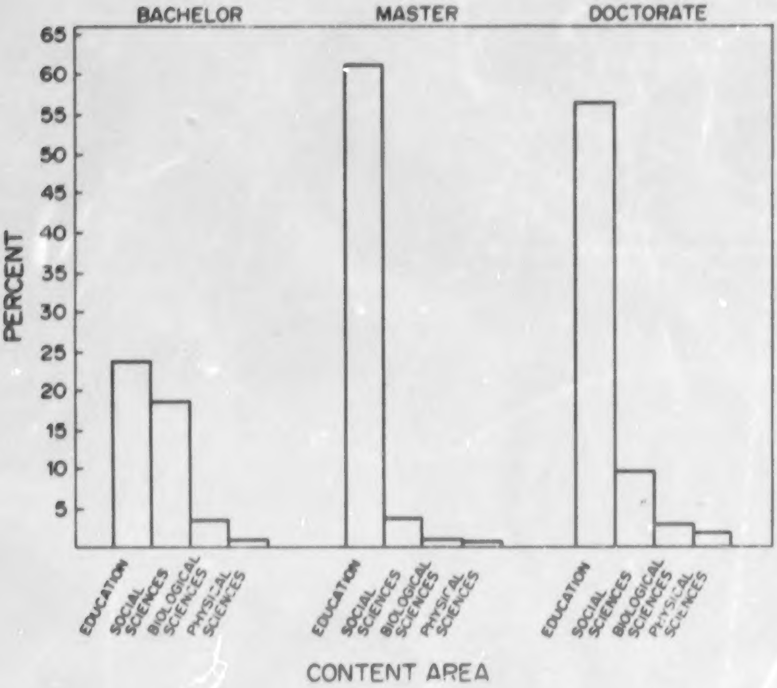
Minority Student Representation among Degrees Granted in Engineering and Science

		Percentage of Degrees Awarded 1975–76								
		Physical Science			Biological Science			Social Science		
	Proportion in U.S. Population 1977	B.S.	M.S.	Ph.D.	B.S.	M.S.	Ph.D.	B.S.	M.S.	Ph.D.
Black	11.6	2.9	2.4	0.9	4.1	3.1	1.3	8.5	5.4	2.6
Hispanic	5.3	1.3	1.0	0.8	1.6	0.8	0.6	2.4	1.8	1.0
Native American	0.4	0.3	0.2	0.2	0.3	0.2	0.1	0.4	0.2	0.2
Asian American	1.3	1.5	2.6	2.5	2.2	1.9	2.5	1.1	1.2	0.9
Total Degrees Granted (Thousands)		21.2	5.4	3.4	54.2	6.6	3.4	126.4	25.9	4.2

SOURCE: *Science Education Databook*, 1980, p. 121.

FIGURE 3.3

Percentage* of Total Degrees Awarded to Black Students by Content Area, 1975–76



$$\text{*Percentage} = \frac{\text{number of blacks enrolled in content areas}}{\text{number of degrees earned by blacks in all fields}} \times 100.$$

minority students will successfully complete their graduate study programs (*Minority Group Participation in Graduate Education,* 1976, p. 9).

The pitfalls, which lead to the high attrition rates, vary from institution to institution. Some researchers have analyzed potential difficulties at large, multicultural universities, while others have focused on the problems encountered at institutions of higher education which have primarily black students. Reed (1978) recognized alienation, stereotyping, and lack of adequate career counselling as three problems often encountered by black graduate students in large institutions of higher education. Of the three problems, alienation has the greatest effect on the black student population at these institutions. Alienation within the college community results in a lack of intellectual interaction which can lead to low academic achievement. The black student encountering such a dilemma may become disillusioned enough to withdraw from graduate study.

Alienation within the college community is often related to the problems of stereotyping. Accurately or inaccurately, black graduate students often are regarded as "special admit" students. Because of this view, black students have not been expected to excel academically at the graduate level. Another problem, discussed by Reed (1978), is the lack of adequate career counselling. This occurs at all levels of education for black students.

The minority graduate school plays an important role in fulfilling both the personal and educational needs of black students. Programs of study leading to graduate degrees are currently available at 28 black institutions. One of these, Alabama A&M University, has been involved actively in this project. Four black institutions have doctorate programs: Howard University, Atlanta University, Meharry Medical College, and Texas Southern University (*Minority Group Participation in Graduate Education*, 1976). Although black students may feel more comfortable in black graduate situations, here, too, they encounter problems. These problems are usually related to financial support (fellowships and assistantships) as well as to the need for laboratory space and equipment. In many ways, they reflect institutional concerns. Consider the following specific priorities listed by black graduate schools:

1. The attainment of equipment and facilities for the achievement of program goals
2. The attainment of financial assistance for institutional development and student aid
3. The recruitment and retention of qualified faculty members
4. The achievement of racial equality among all ethnic groups
5. The creation of realistic administrative standards which allow the institution to function significantly in the educational mainstream without cultural barriers
6. The development, extension, and improvement of programs of study in the social, physical, and biological sciences as well as in business and teacher training
7. The development of programs of study in such areas as urban affairs, allied health, recreation and leisure, and multicultural affairs (*Minority Group Participation in Graduate Education*, 1976).

The lack of educational opportunities is reflected in the occupational data, described by Hale (1978, p. 205S). This study indicates that although blacks constitute 11% of the U.S. population, they account for only 1% of the physicians and engineers and 2% of the dentists. Furthermore, they comprise only about 5% of the labor force in science and engineering fields.

In summary, lack of financial assistance and of career counselling as well as alienation and stereotyping are among the major factors contributing to the low enrollment patterns and the high attrition rates of black graduate students. In spite of often strong desires to obtain graduate degrees, these obstacles may prove insurmountable. Removing these barriers is a task for all institutions of higher education. As the National Board on Graduate Education aptly states: "Increased minority participation in graduate education is an important goal to be realized for social, economic, intellectual, and cultural well-being of all persons. It is for the collective benefit of society that the representation of minority group persons among those earning advanced degrees be increased" (*Minority Group Participation in Graduate Education*, 1976, p. 1).

Summary

Historically, education in the sciences for minority students has been almost nonexistent. Today opportunities have been opened and more minority students are choosing science majors as undergraduate and graduate students. Although programs such as the cooperative Baccalaureate and Doctor of Veterinary Medicine degree, described in Chapter 1, help to alleviate barriers, many obstacles remain. Before educational and employment equity is possible, black students must be encouraged to enter science fields. This encouragement must begin in early adolescence where curricular materials, instructional strategies, and appropriate role models all contribute to positive attitudes toward and higher achievement levels in science. Success will, then, lead to participation.

NOTES

1. "Open admission" refers to the practice of admitting all applicants usually with evidence of a high school education or its equivalent.

REFERENCES

Black, T. "Black Colleges Playing a Tough Numbers Game." *The Birmingham News*, August 7, 1980, p. 6A.

Hale, F.W. Jr. "An Agenda for Excellence: You Can Make the Difference. *Phi Delta Kappan* 60 (1978):204S-206S.

Helgeson, S.L.; Blosser, P.E.; and Howe, R.W. *The Status of Pre-College Science, Mathematics, and Social Science Education*: 1955-1975 (Volume I: Science Education). Washington, D.C.: U.S. Government Printing Office, 1978.

Ignatz, M.B. "Low Black Enrollment in Chemistry and Physics Courses." *Science Education* 59 (1975):517-573.

Jencks, C. *Who Gets Ahead? The Determinants of Economic Success in America.* New York: Basic Books, Inc., 1979.

Kahle, J.B. "An Analysis of Minority Attitudes toward Science from the 1976-77 National Assessment of Science Results," in *National Assessment of Educational Progress, Attitudes Toward Science* (NAEP Science Report No. 08-S-2). Denver: Education Commission of the States, October 1979.

Levine, D., and Bane, M. *The "Inequality" Controversy: Schooling and Distributive Justice.* New York: Basic Books, Inc., 1975.

Minority Group Participation in Graduate Education. Number five. Washington, D.C.: National Board on Graduate Education, June 1976.

National Center for Education Statistics. *The Condition of Education.* NCES-80-400. Washington, D.C.: U.S. Department of Education, 1980.

National Research Council (NRC). *Science, Engineering, and Humanities Doctorates in the United States, 1977 Profile.* Washington, D.C.: National Academy of Sciences, 1978.

Office of Civil Rights. *Racial and Enrollment Data from Institutions of Higher Education.* Washington, D.C.: U.S. Government Printing Office, 1976.

Pallone, N.; Hurley, R.; and Richard, F. "Further Data on Key Influence of Occupational Expectations Among Minority Youth." *Journal of Counseling Psychology* 20 (1973):484-486.

Reed, R.J. "Increasing the Opportunities for Black Students in Higher Education." *Journal of Negro Education* 47 (1978):143-150.

Remick, H., and Miller, K. "Participation Rates in High School Mathematics and Science Courses." *The Physics Teacher* (May 1978):281.

Rowe, M.B. "The Forum: Why Don't Blacks Pick Science?" *The Science Teacher* 44 (1977):34-35.

Shorter, C. "The Education of Black Women." Paper presented at the Conference on the Black Woman: Her Past, Present, and Future, Purdue University, West Lafayette, Indiana, March 30-31, 1979.

Stake, R.E.; Easley, J.; *et al. Case Studies in Science Education* (Volume I: The Case Reports; Volume II: Design, Overview, and General Findings). Washington, D.C.: U.S. Government Printing Office, 1978.

Thomas, S. "Black Colleges Existence Threatened." *Birmingham Times,* August 14, 15, 16, 1980.

Toward Equal Educational Opportunity. Report of the Select Committee on Equal Educational Opportunity United States Senate. Cardasco, F., ed. New York: AMS Press, Inc., 1974.

Weinberg, M. *Minority Students: A Research Appraisal.* Washington, D.C.: U.S. Government Printing Office, 1977.

Weiss, I.R. *Report on the 1977 National Survey of Science, Mathematics, and Social Studies Education.* SE78-72. Washington, D.C.: National Science Foundation, U.S. Government Printing Office, 1978.

Wilkinson III, J.H. *From Brown to Bakke, The Supreme Court and School Integration: 1954-1978.* New York: Oxford University Press, 1979.

Williams, W.C. *Annual Report of the President.* Birmingham, Alabama: Miles College, 1980-1981.

4 Reports from the Field

Preface

The papers included in Chapter 4 are a compilation of the research projects conducted by each participant on her home campus. They are, therefore, reports from the field. The women each identified a learning problem on her campus, collected data about it, and presented solutions to alleviate it. Each paper has a different focus.

The individual papers were written to stand alone; therefore, the reader may find some repetition of background information. In addition, different interpretations for similar results may be found, as each researcher applied different statistical analyses and explained her data in the context of her situation.

The demographic survey and standardized instruments utilized in the individual studies are included in Appendices C and D and the nature of the instruments is more fully described in Chapter 5.

An Investigation of Ability/Aptitude, Personal, and Social Characteristics of Black College Students

Nell R. Anthony
and
Olivia H. Sanders

An alteration of instructional mode and materials may prove to be especially important in science courses for minority students. The data collected in this study indicate that the student sample was highly field-dependent; yet, they were enrolled in an introductory biology course which required exploration and discovery.

One major challenge in educational research is to determine which instructional methods facilitate learning for various kinds of students. In general, teachers do not understand how students learn, how they solve problems, or how they perceive and analyze various stimuli in their learning environments.

Cross (1976) has asserted that ". . . if we expect learning to have a maximum impact on the development of individuals, we must offer options with respect to pacing, method of instruction, and curricular content." In addition, Feldman (1969) has stressed that the uniform pattern of education has to be replaced with a variety of activities designed to match differences in teaching and learning style. With more thorough knowledge of student characteristics and their interrelationships, it may be possible to prescribe teaching methods and materials appropriate for particular types of students.

The purpose of this study was to investigate the characteristics of students enrolled in an introductory college biology course at a predominantly black, southern university. A related goal was to investigate the possible relationships between selected characteristics. The student characteristics identified for this study were grouped into three areas. First, ability and aptitude were assessed. Second, personal factors were considered based upon data concerning locus of control orientation, cognitive style, number and enjoyment of spatial experiences, and attitudes toward biology. Third, family and background factors were analyzed from data collected from a demographic survey.

Instruments

The first category of student characteristics examined was aptitude and ability. Aptitude, expressed as the ability to acquire knowledge, was measured by the School and College Aptitude Test (SCAT). In addition to the total score (SCATTOT), scores for the verbal (SCATV) and the quantitative (SCATQ) sections of the test were gathered and studied. The Otis-Lennon Mental Ability Test (OLMAT) was used to assess school ability.

The second category, personal factors, utilized data from four sources. Cognitive style, a consistent mode of intellectual functioning including stimulus perception and information processing, was studied as a possible indicator of success in introductory science courses. Witkin, *et al.*, (1977) have identified and studied the cognitive style of field-independence (FI) and field-dependence (FD). Field-independent individuals use a more analytical and intuitive approach to problem solving. As Douglass (1976) states, "A field independent (analytical) person is able to analyze a complex stimulus and to distinguish, retain, and coordinate relevant items extracted from a complex and distracting background." Conversely, individuals who are field-dependent are more general and global in their approach to problem solving. They may be more easily distracted by irrelevant factors in a problem. Douglass (1976) has indicated that such an individual is ". . . less likely than the analytical individual to be able to structure a stimulus and is unable to perceive parts of a field as discrete from the overall field of reference." The measure employed to assess the degree of field-independence is the Group Embedded Figures Test (GEFT).

The personality attribute referred to as locus of control is an expression of the extent to which individuals believe that they, rather than outside factors, control their own lives. While internal individuals believe their own behaviors determine their fate, external individuals believe their lives are not under their own control. Research in this area includes studies done by Phares (1957), Rotter (1966), and Strickland (1973). The Rotter Internal/External (I/E) Scale has been used to gather data on this attribute.

Two other personal dimensions were assessed and the data analyzed. One was participation in spatial experiences such as golf or chess and one's enjoyment of these activities. The Spatial Experience Questionnaire (SEQ) was used for this purpose. In addition, a Likert-type biology attitude scale was used to gather information on the subject's attitudes toward biology.

Finally, a background information survey, developed by a group of black, women faculty from five southern minority colleges and universities, was used to gather demographic data for each student. The data collected include gender, age, number of work-hours per week, academic major, size and socioeconomic descriptions of home community, and parental level of education. For each of the 26 items on this survey, the subjects selected the most appropriate response.

Subjects

The 142 freshman and sophomore students in this study were enrolled in an introductory laboratory biology course at a predominantly black, land-grant institution in northern Alabama. Demographic data describing this sample are presented in Table 4.1. In this sample, 82% of the subjects are between the ages of 16 and 21. Thirty-two percent are freshmen, while 46% are sophomores. Although enrolled in biology, 31% are education majors while only 10% major in science. Forty-one percent are from small communities (population less than 25,000). In addition, 37% of the subjects are from families in which at least one parent has completed high school.

Analyses

The statistical procedures applied to the data included the Pearson Product Moment Correlation, one-way analysis of variance, and stepwise multiple regression. Student characteristics were organized into three broad areas for consideration: aptitude and ability factors, personal factors, and family/

TABLE 4.1

Demographic Data: Percentages Describing Personal and Community Characteristics

Variable	Percentage
Age	
16-2[illegible]	82
22-25	13
26-35	7
Sex	
Female	53
Male	47
Class	
Freshman	32
Sophomore	46
Community Type	
Less than 25,000	41
25,000-200,000	28
Over 200,000	27
Parental Education	
No High School	19
Only High School	37
Family Size	
1-2 Siblings	5
3-4 Siblings	53
5 or More Siblings	42
Work Hours/Week	
Less than 5	49
5-20	27
More than 20	10
Major	
Social Sciences	23
Science	10
Education	31

background factors. A correlational design was employed to investigate interrelationships of paired variables. A stepwise multiple regression was used to study variance and degree of change in the variance, since this technique increases the accuracy of prediction. A one-way analysis of variance was performed to determine the significance of differences in the means of SCATV, SCATQ, SCATTOT, OLMAT, and SEQ when the subjects were grouped by scores on the CEFT.

Results

Table 4.2 presents the intercorrelation coefficients for the aptitude and ability factors. School ability, as indicated by OLMAT scores, correlates with

TABLE 4.2

Pearson Product Moment Correlation Coefficients for Aptitude and Ability Variables

	N	SCATV	SCATQ	SCATTOT
SCATQ	121	.24*		
SCATTOT	121	.82*	.75*	
OLMAT	119	.79*	.23*	.67*

KEY: SCATV = School-College Aptitude Test, verbal score; SCATQ = School-College Aptitude Test, quantitative score; SCATTOT = School-College Aptitude Test, total score; OLMAT = Otis-Lennon Mental Ability Test.

SIGNIFICANCE: *$p < .01$.

TABLE 4.3

Summary Table: Stepwise Multiple Regressions (N = 142)

		INDEPENDENT VARIABLES			
Dependent Variables		OLMAT	GEFT	SEQ	I/E
	Step:	1	2	3	4
SCATV					
R^2		.58	.64	.65	.65
R^2 Change		.58	.06	.00	.00
SCATQ					
R^2		.16	.20	.21	.21
R^2 Change		.16	.05*	.01**	.00
SCATTOT					
R^2		.40	.53	.57	.57
R^2 Change		.40	.13	.04*	.00

SIGNIFICANCE: *$p < .05$; **$p < .01$.

aptitude, as measured by SCAT scores. A very high correlation (.79) is found between scores on SCAT and those on OLMAT. As expected, the total aptitude scores (SCATTOT) correlates with each of its parts. The ability measure used (OLMAT) was the best predictor of scholastic aptitude as measured by the SCATTOT. A stepwise multiple regression explored the identified relationships between ability and aptitude measures. Table 4.3 supports the correlations presented in Table 4.2 and shows that OLMAT accounted for 58% of the total variance of SCAT verbal scores and 40% of the total variance of SCAT total scores.

TABLE 4.4

Pearson Product Moment Correlation Coefficients between Personal Variables and Ability and Aptitude Variables
(N = 90)

	SCATV	SCATQ	SCATTOT	OLMAT
I/E	–.08	–.09	–.10	–.08
SEQ	–.08	–.09	–.10	–.08
Attitude	.07	.46**	.33**	.10
GEFT	.50*	.32*	.53*	.38*

SIGNIFICANCE: $^{*}p < .01$; $^{**}p < .001$.

Personal variables such as cognitive style (GEFT), locus of control orientation (I/E), number and enjoyment of spatial experiences (SEQ), and attitude (toward biology) were analyzed in relation to ability/aptitude measures. In general, slightly negative and very low correlations were found, as shown in Table 4.4. However, attitude scores correlated significantly with SCATQ ($n = 90$, $r = .46$, $p \leq .001$) and SCATTOT ($n = 90$, $r = .33$, $p \leq .001$) scores. A possible explanation is that students who enjoy biology and who have more positive attitudes toward it are students with stronger quantitative skills. The positive correlation between attitude scores and scores of the SCAT quantitative portion of the test supports this assumption. In addition, all scores on ability and aptitude measures correlated significantly with high scores on the GEFT test of field-independence/field-dependence. High scores on GEFT test indicate a more field-independent mode which correlated positively and significantly ($p \leq .01$) with scores on SCATV, SCATQ, SCATTOT, and OLMAT.

Relationships between demographic variables and ability/aptitude or personal variables are shown in Table 4.5. Ability and aptitude variables such as SCATV, SCATQ, SCATTOT, and OLMAT correlate significantly with increased parental education. Table 4.5 shows a significant, negative correlation between family size and other measures. The negative direction of the correlation is due to coding family size from small (1) to large (5). In this population, students from smaller families, i.e., those with fewer siblings, were more field-independent.

Another significant correlation is found between attitude toward biology and the number of reading materials available in the home. The positive correlation, perhaps, is indicative of increased motivation and interest when students have access to newspapers and magazines which include science articles. Significant correlations are not found between the demographic variables, college major and size of home community, and any ability/aptitude or personal variable assessed.

Relationships were revealed between cognitive style and all ability and aptitude measures (Table 4.4) as well as between cognitive style and the background variable of family size (Table 4.5). Therefore, an in-depth analysis of cognitive style was performed. Subjects were divided into two groups, field-independent and field-dependent, according to the mean score for the GEFT

TABLE 4.5

Pearson Product Moment Correlation Coefficients between Selected Demographic Variables/Ability and Aptitude Variables/Personal Variables

	SCATV	SCATQ	SCATTOT	OLMAT	GEFT	IE	ATT	SEQ
Community Size	.07 (95)	.03 (95)	.06 (95)	.14 (94)	– .01 (81)	.04 (107)	– .03 (101)	.13 (107)
Parental Education	.25* (92)	.22* (92)	.31** (92)	.34** (93)	.17 (80)	.04 (107)	– .10 (100)	– .13 (106)
Family Size	– .05 (94)	– .11 (94)	– .10 (94)	– .09 (95)	– .20* (82)	.09 (109)	.00 (102)	.06 (108)
Amount of Reading Material in Home	.07 (97)	.04 (94)	.07 (94)	.09 (95)	– .05 (82)	.11 (108)	.28** (102)	.05 (107)
College Major	.08 (94)	.08 (94)	– .06 (94)	– .09 (92)	– .05 (79)	– .11 (106)	– .02 (99)	– .22 (105)

KEY: ( ) = N.

SIGNIFICANCE: $^*p < .05$; $^{**}p < .01$.

test ($\overline{X} = 4.95$). Scores falling above the mean were used to characterize field-independent students, while scores falling below the mean indicated field-dependent students. A one-way analysis of variance (Table 4.6) was employed to ascertain if there were significant differences between these two groups on their mean scores on SCATV, SCATQ, SCATTOT, SEQ and OLMAT. A significant difference in favor of the field-independent group was found with all measures of ability and aptitude.

Discussion and Implications

Review of the results indicates that there are many important factors affecting student achievement within a specific learning environment. The results raise many questions as to how one can effectively change a learning environment to benefit students. Possible preliminary actions are suggested to obtain this goal.

Since the OLMAT and the SCAT are both academic tests, it is expected that there will be a relatively high intercorrelation between the scores on these tests. The results corroborate this expectation. In addition, a positive correlation has been found between GEFT scores and scores on both the OLMAT and the SCAT. One implication is that field-independent people, those who score high on the GEFT, tend to score higher on selected school measures of aptitude and ability. Since both the OLMAT and the SCAT tests are lengthy and involve a longer testing time than the Group Embedded Figures Test, these results suggest the GEFT may be a useful screening tool to identify potential academic success. It is a culture-free paper-and-pencil test, requiring 12 minutes, and it is scored easily. Instructors may use it to identify quickly students who may need extra help in a course.

One of the purposes of this study was to investigate student characteristics, such as learning style and locus of control orientation, and their relationship to achievement. Correlations were established between field-independence and high scores on ability and aptitude tests. Furthermore, a one-way analysis of variance found significant differences between field-independent and field-dependent groups based on their mean scores on various academic measures. This finding implies that a student's cognitive style may have a strong relation to his/her aptitude for acquiring knowledge in an academic setting.

Perhaps the most important educational implication in cognitive style research is the hypothesized relationship between teacher instructional style, student cognitive style, and learning performance. Specifically, Cross (1976) has suggested that optimal learning results when the instructional style of the teacher matches the learner's cognitive style. Researchers such as Carpenter, McLeod, and Skvarcious (1976), Grieve and Davis (1971), and Koran, Snow,

TABLE 4.6

One-Way Analysis of Variance for GEFT Scores and Selected Measures

Test Group	N	df Between df Within	F Ratio	F Probability	Table Value	Mean	Standard Deviation
SCATV							
FI*	33	1	27.42	.000	$F_{95} = 3.94$*	20.64	7.46
FD	88	119				14.60	4.83
SCATQ							
FI	33	1	12.49	.001	$F_{95} = 3.94$*	17.40	6.23
FD	88	119				13.70	4.66
SCATTOT							
FI	33	1	34.28	.000	$F_{95} = 3.94$*	38.03	9.74
FD	87	118				28.30	7.44
OLMAT							
FI	34	1	16.48	.000	$F_{95} = 3.92$*	37.94	14.71
FD	89	121				28.37	10.34
SEQ							
FI	25	1	.195	.650	$F_{95} = 3.94$	47.12	15.54
FD	86	105		.660		45.44	17.08

*Subjects were divided into FI/FD groups using GEFT $\overline{X} = 4.95$. Students scoring above 4.95 were considered FI; those scoring below, FD.

and McDonald (1971) have found that when an instructional style and student cognitive style are matched, content achievement is increased. Witkin, *et al.* (1977) have reported that field-independent students prefer greater isolation and social distance than field-dependent students. Likewise, field-independent students are generally more interested in theoretical and abstract ideas. Since field-independent students may prefer individual exploration of ideas, these students should prefer a discovery style of teaching. According to Macneil (1980), the discovery method of instruction involves teaching strategies which state the generalizations to be taught at the end of an instructional sequence, utilize little instructor guidance, and emphasize student centered presentations; such as discussions, role-playing, self-paced laboratory exercises, and individual and group problem solving session. On the other hand, some researchers have found that field-dependent people learn more, based on achievement tests, with an instructor who uses an expository classroom style. This style is characterized by presenting generalizations as the initial step in the instructional sequence, by using a high degree of instructor guidance, and by focusing on teacher centered presentation methods such as lecture and demonstrations (Macneil, 1980). Research indicates that field-dependent students may benefit from added structure in the learning environment.

Since cognitive style is a stable personality characteristic (Witkin, *et al.*, 1977), most college instructors cannot change their teaching style to match that of the majority of their students. However, if instructors utilize the GEFT test to assess students' cognitive learning styles, they could selectively incorporate examples, sequence lectures, and provide laboratory experiences appropriate for different cognitive styles. An alteration of instructional mode and materials may prove to be especially important in science courses for minority students. The data collected in this study indicate that the student sample was highly field-dependent; yet, they were enrolled in an introductory biology course which required exploration and discovery. The field-independent subsample of students achieved better on all ability and aptitude measures and, therefore, should have been able to learn more in this particular learning environment.

REFERENCES

Carpenter, L.; McLeod, D.B.; and Skvarcious, R. "Cognitive Style and Mathematics Learning: The Interaction of Field Independence and Instructional Treatment in Numeration Systems." Paper presented at annual meeting of the National Council of Teachers of Mathematics, Atlanta, 1976.

Cross, P. "Beyond Education for All—Toward Education for Each." *College Board Review* 99 (1976):5-10.

Douglass, C. "The Effect of Instructional Sequence and Cognitive Style on the Achievement of High School Biology Students." Unpublished Ph.D. dissertation, Purdue University, 1976.

Feldman, M.A. "Definition of Comprehensive Education." *ES '70 News* 1 (1969):6.

Grieve, T.D., and Davis, J.K. "The Relationship of Cognitive Style and Method of Instruction to Performance in Ninth Grade Geography." *Journal of Educational Research* 65 (1971):137-141.

Koran, M.L.; Snow, R.E.; and McDonald, F.J. "Teacher Aptitude and Observational Learning of a Teaching Skill." *Journal of Educational Psychology* 62 (1971):219-228.

Macneil, R.D. "The Relationship of Cognitive Style and Instructional Style to the Learning Performance of Undergraduate Students." *Journal of Educational Research* 73 (1980):354-359.

McDaniel, E.D.; Guay, R.; Ball, L.; and Kulloff, M. "Spatial Experience Questionnaire." West Lafayette, Indiana: Department of Education, Purdue University, 1978.

Oltman, P.K.; Raskin, E.; and Witkin, H. "Group Embedded Figures Test." Palo Alto, California: Consulting Psychologists Press, 1971.

Otis, A.S., and Lennon, R. "Otis-Lennon Mental Ability Test." Chicago: The Psychological Corporation, Harcourt-Brace-Jovanovich, 1968.

Phares, E.J. "Expectancy Changes in Skill and Chance Situations." *Journal of Abnormal and Social Psychology* 54 (1957):339-342.

Rotter, J. "Generalized Expectancies for Internal versus External Control of Reinforcement." *Psychological Monographs: General and Applied* 80 (1966):1-28.

Russell, J., and Hollander, S. "A Biology Attitude Scale." *American Biology Teacher* 37 (1975):270-273.

"School and College Aptitude Test." Princeton: Cooperative Tests and Services, Educational Testing Service, 1976.

Strickland, B. "Locus of Control: Where Have We Been and Where Are We Going?" Paper presented at the 81st annual meeting of the American Psychological Association, Montreal, August 27-31, 1973.

Witkin, H.A.; Moore, C.A.; Goodenough, D.R.; and Cox, P.W. "Field-Dependent and Field-Independent Cognitive Styles and Their Educational Implications." *Review of Educational Research* 47 (1977):1-64.

A Comparison of the Effect of Three Instructional Methods on Achievement of Biology Students in a Black Southern College

Charlotte Carter

The audio-tutorial mode of instruction is costly for small, minority colleges; however, based on findings in this study, A-T instruction may be cost accountable in terms of improved achievement levels. It may be worth the expense to implement and to expand audio-tutorial instruction in several other content areas for black college students. Furthermore, consortia of small colleges such as the Alabama Center for Higher Education could mutually develop audio-tutorial packets.

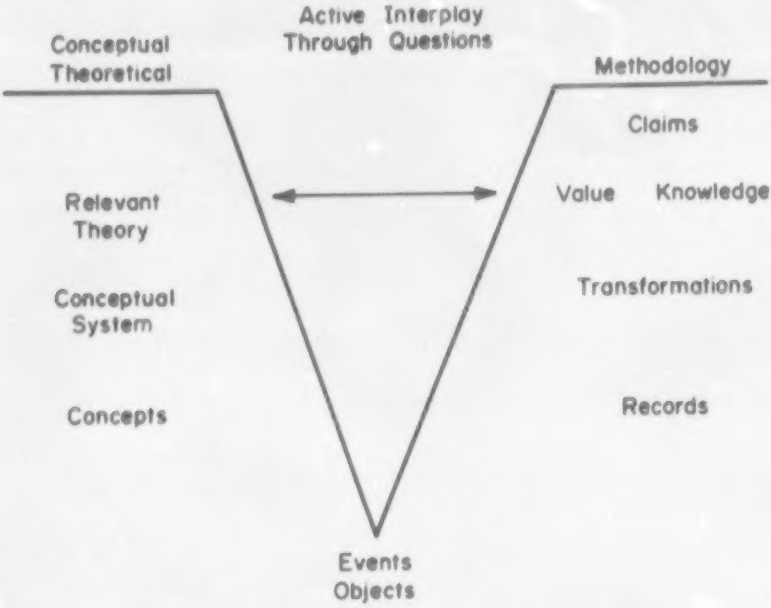
Introduction

The hypothesis that highly specific instructional methods may cause differences in student achievement has appeared in the literature repeatedly during the last six years. If this idea is tenable, instruction for black students enrolled in a small, liberal arts college, or indeed any students, should be designed to enhance their achievement. Research by Kahle, *et al.* (1976) demonstrated that individualized audio-tutorial instruction is as effective as traditional group instruction in educating urban minority students in biology. In addition, Cobb (1977) revealed that although there was no significant difference in the biology achievement on post-test scores between audio-tutorial (A-T) and non-audio-tutorial (NA-T) groups in the life-science course in a small, minority college, students preferred the audio-tutorial method of instruction.

Other research has shown students are more efficient learners when they understand the objective of the instruction (Peterson and Carlson, 1979). For example, one method of illustrating the structure of knowledge of a discipline is by using Gowin's "V." The "V" concept, developed by Robert Gowin of Cornell University, is a potentially valuable tool in identifying instructional sequences as well as conceptual organization of subject-matter for learners. A brief description of Gowin's "V" and its uses has been reported by Novak (1979). He states that Gowin's "V" (Figure 4.1) illustrates how instructional objectives may be organized to create a learning hierarchy as well as a relevant sequence of learning experiences. According to Novak, these two types of organization must precede efficient, meaningful learning. Novak (1979) indicates that on the left side of the "V" a hierarchy of learning should exist between concepts, conceptual

FIGURE 4.1

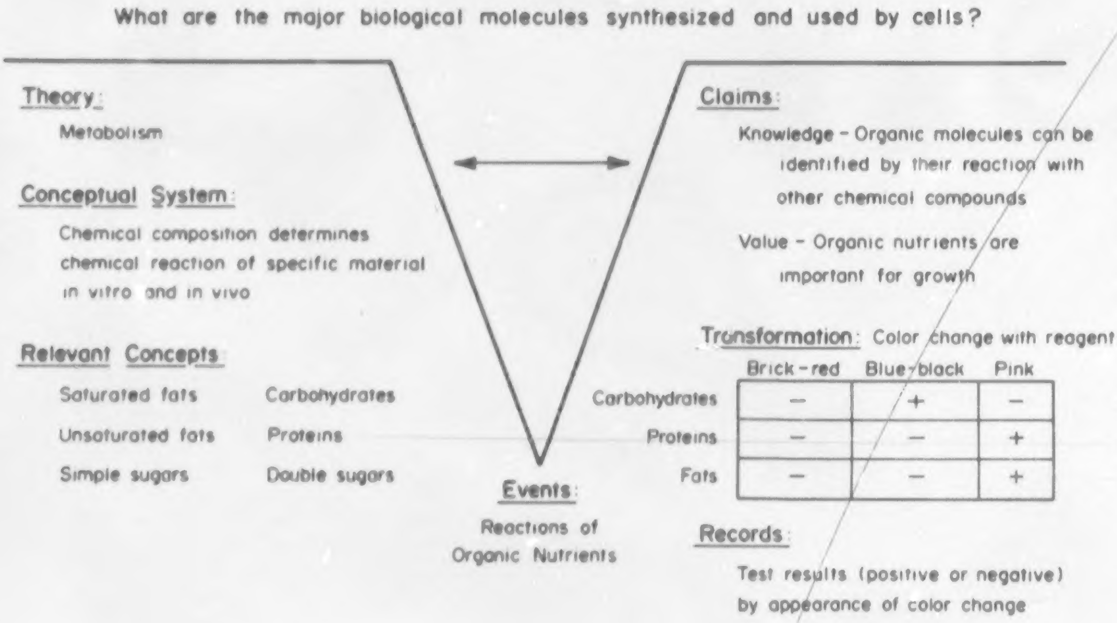
Generalized Model of Gowin's "V"


Active Interplay
Through Questions
Conceptual
Theoretical
Methodology
Claims
Relevant
Theory
Value Knowledge
Conceptual
System
Transformations
Concepts
Records
Events
Objects

SOURCE: Novak, 1979

systems, and theories. On the right side of Gowin's "V" are the procedures the students use in the learning process. These procedures include recording the observations of events or objects; organizing and transforming these records into tables, graphs, charts, and statistical values; and finally, drawing "conclusions" in the form of knowledge and/or value claims. Figure 4.2 is an example of sequencing a laboratory exercise on Gowin's "V." A laboratory exercise, "Biological Molecules Synthesized by Organisms," illustrates its use. At the base of the "V" in Figure 4.2 are the objects or events.

This study evaluated the comparative effectiveness of audio-tutorial instruction, conventional laboratory instruction, and conventional laboratory instruction supplemented with Gowin's "V" on the biology achievement of students at a small, minority, liberal arts college. Although some research indicates that minority students achieve more with A-T instruction, the cost of that mode has



What are the major biological molecules synthesized and used by cells?

Theory:
Metabolism

Conceptual System:
Chemical composition determines chemical reaction of specific material in vitro and in vivo

Relevant Concepts:

Saturated fats	Carbohydrates
Unsaturated fats	Proteins
Simple sugars	Double sugars

Events:
Reactions of Organic Nutrients

Claims:
Knowledge – Organic molecules can be identified by their reaction with other chemical compounds

Value – Organic nutrients are important for growth

Transformation: Color change with reagent

	Brick-red	Blue-black	Pink
Carbohydrates	–	+	–
Proteins	–	–	+
Fats	–	–	+

Records:
Test results (positive or negative) by appearance of color change

FIGURE 4.2

A Sample Gowin's "V" Applied to a Laboratory Exercise on "Biological Molecules Synthesized by Organisms" been prohibitive for many small colleges. Therefore, if the use of Gowin's "V" is as effective with no increased cost, it may be a more appropriate instructional format for these colleges.

Experimental Design

The subjects involved in this study were enrolled in a one-semester, introductory life-science course. The three instructional methods used were:

1. Treatment group 1: self-paced audio-tutorial laboratory instruction
2. Treatment group 2: conventional laboratory instruction with no explanation of the instructional objectives for each laboratory exercise
3. Treatment group 3: conventional laboratory instruction and an explanation of the instructional objectives for each laboratory exercise through the use of Gowin's "V."

Students in group 1 used the self-paced audio-tutorial method of instruction, supplemented by a study guide for laboratory work. Students in groups 2 and 3 used a textbook in a regular classroom setting and were involved in identical laboratory experiences. Additionally, students in group 3 received instruction about Gowin's "V" and used it in preparing laboratory reports. All three groups received equivalent material and instructional time. The study was replicated during the second semester.

Five laboratory exercises were completed over a five-week period by students in all treatment groups. These exercises included the following topics:

1. Cell Membrane Activity: The Physical Aspects of Life
2. Measurement of Enzyme Activity by Sampling
3. The Biochemistry of DNA-RNA
4. Analysis of a Protein
5. Microbiological Techniques.

Prior to the treatment, all subjects were given an achievement pretest covering the course content as well as a battery of tests to assess their analytical thinking ability, locus of control, spatial experiences, and attitudes toward biology.

Instruments

Each student's attitude toward biology was assessed with a questionnaire developed by Russell and his associates, the Biology Attitude Scale (Russell and

Hollander, 1975). Fourteen statements on the questionnaire required students to indicate the extent to which they agreed with the statements; for example, "I really like biology." The remaining eight items addressed the student's attitude toward biology by asking the student to rate biology along a continuum between two extremes. The words "worthless" and "valuable" are examples of descriptors used to rate these items.

Witkin's Group Embedded Figures Test (GEFT) (Oltman, *et al.*, 1971) was given to determine the degree to which a student was analytical. This test required a student to separate a simple geometric shape from a complex field into which it had been embedded.

Students' locus of control orientations were assessed by Rotter's I/E (Internal/External) Scale (Rotter, 1966). This scale measured the degree to which individuals believed that they control their own lives. If they felt they were in control, they were described as internal. External individuals believed their destiny was not under their personal control. The I/E questionnaire is composed of 23 forced choice items and six filler items. It is scored by assigning one point to each item which is considered more consistent with an external locus of control. Those individuals with high scores are characterized as having an external locus of control, while low scores characterize individuals with an internal locus of control.

The Spatial Experience Questionnaire (SEQ) (McDaniel, *et al.*, 1978) was administered to assess the extent of the students' participation in and enjoyment of spatial experiences. All of these instruments were administered prior to the experimental period.

A 50-item biology achievement test of course content was developed and administered during the fourth week of the semester. Mean scores from this test were used as a standard for determining the equivalency of treatment groups. An equivalent form was administered as the achievement post-test approximately five weeks after the instruction period began.

Analyses

Pre-test and post-test means for the three treatment groups were compared by one way analysis of variance in the first segment of the analysis. A Newman-Keuls test was performed on the post-test means when significant differences were found among the groups in order to identify the homogeneous subsets. In the second segment of the analysis, Pearson Product Moment correlation coefficients were computed to identify statistically significant relationships between selected variables. The treatments in this study were replicated during the second semester using three different groups of students.

Results and Discussion

Demographic data for all subjects are summarized in Table 4.7 The mean scores and the total possible points for all measures are shown in Table 4.8. The subjects in this study had positive attitudes toward biology and their attitudes did not change significantly between the beginning and the end of this one semester biology course. The analysis of pre-test means for the three treatment groups, Table 4.9, indicated than there were no significant differences between the three groups on prior knowledge as measured by the pre-test. Therefore, the groups were assumed equivalent prior to the experimental treatment.

TABLE 4.7

Descriptive Data by Treatment for All Subjects

Age in Years	%	Class	%	Sex	%	Declared Ethnic Origin	%
16-21	82.5	Freshman	47.5	Female	55.0	African	2.5
22-25	10.0	Sophomore	32.5	Male	45.0	American Black	95.0
26-35	7.5	Junior	15.0			Hispanic	—
36-45	—	Senior	2.5			White	2.5
Over 45	—	Unclassified	5.0			Other	—

TABLE 4.8

Total Points and Means by Semester for Selected Measures

Measure	Possible Totals	Means by Semester 1	2	1 + 2
Attitude	110	76.30	73.22	74.40
Post-Attitude	110	78.60	76.23	77.32
IE	23	9.03	9.92	9.58
Spatial Experience	150	43.88	45.88	43.87
GEFT	18	4.60	2.98	3.66
Pre-Test	50	17.13	17.29	17.22
Post-Test	50	22.53	21.70	22.10

KEY: IE = Internal/External; GEFT = Group Embedded Figures Test

TABLE 4.9

One-Way Analysis of Variance Comparing Pre-Test Means for Three Treatment Groups by Semesters

Semester	Group	N	$\overline{X}$	Source	dF	MS	F Ratio	F Probability
1	1	16	18.75	Between	2	36.23	1.53	.23
	2	12	16.33	Within	37	23.78		
	3	12	15.75					
2	1	27	18.26	Between	2	45.62	1.73	.19
	2	14	16.10	Within	49	26.32		
	3	11	15.18					

KEY: Group 1 = Audio-tutorial; Group 2 = Conventional; Group 3 = Conventional plus Gowin's "V".

After the experimental period, differences in achievement levels between treatment groups were examined (Table 4.10) by a one way analysis of variance on the post-test scores of the content test. This analysis showed that a significant difference in achievement existed between the three groups. The Newman-Keuls test (Table 4.10) identified two homogeneous subsets for each semester. During each semester, one subset was composed of group 1 (audio-tutorial) while the second subset was composed of group 2 (conventional) and group 3 (conventional plus Gowin's "V"). These analyses indicated that the post-test mean of group 1 was significantly higher than the post-test mean of group 3 for both semesters. Therefore, this study supported earlier findings that minority students perform better using self-paced, audio-tutorial format than a formal, conventional class format (Kahle, *et al.*, 1976).

The few significant intercorrelation coefficients of the various measures investigated in this study are shown in Table 4.11. Significant positive correlations were found between the degree of field-independence as measured by the GEFT and the SEQ ($r = .29$, $n = 93$), the content pre-test ($r = .26$, $n = 88$), and the content post-test ($r = .18$, $n = 90$). Significant negative correlations were found between the degree of field-independence as measured by the GEFT and IE ($r = -.24$, $n = 94$), and the final course grade ($r = -.29$, $n = 62$). The negative correlations found were a function of the scales used. A low score for I/E indicates an internal locus of control and course grades were coded from 1 through 6 with A grades receiving 1. Field-dependent students were found to be

TABLE 4.10

One-Way Analysis of Variance Comparing Post-Test Means for Three Treatment Groups by Semesters and Newman-Keul Subsets

Semester	Group	N	$\overline{X}$	Source	dF	MS	F Ratio	F Probability	Newman-Keul Subsets (by means)
1	1	16	25.69	Between	2	145.35	5.48	.01	3 2 19.42 21.42
	2	12	21.42	Within	37	26.52			
	3	12	19.42						1 25.69
2	1	26	23.19	Between	2	93.66	3.20	.05	3 2 18.71 20.92
	2	13	20.92	Within	50	29.32			
	3	14	18.71						2 1 20.92 23.19
1 + 2	1	42	24.14	Between	2	223.05	8.09	.001	3 2 19.33 20.27
	2	22	20.27	Within	88	27.59			
	3	27	19.33						1 24.14

KEY: Group 1 = Audio-tutorial; Group 2 = Conventional; Group 3 = Conventional plus Gowin's "V."

TABLE 4.11

Significant Pearson Product Moment Correlation Coefficients between Group Embedded Figures Test and Selected Variables

	IE	SEQ	Grade	Pre-Test	Post-Test
GEFT	−.24	.29	−.29	.26	.18
	(94)	(93)	(62)	(88)	(90)
	p = .01	p = .002	p = .01	p = .01	p = .04

KEY: IE = Locus of control (low score = Internal); GEFT = Group Embedded Figures Test (high score = Field Independent); Grade = A = 1, B = 2, C = 3, D = 4, F = 5, I = 6; SEQ = Spatial Experience Questionaire (high score = frequent and enjoyable activities).

more externally oriented and had participated in and/or enjoyed fewer spatial experiences than field-independent students. In addition, field-dependent students scored lower on both the pre-test and post-test content tests and achieved lower course grades than the field-independent students. GEFT scores correlated significantly with course performance and, therefore, may be useful as a predictor of achievement performance in biology classes for subjects at a selected southern, black college.

Implications

Although studies describing a possible relationship between instructional method and academic achievement do not necessarily indicate a cause and effect relationship, there is increased evidence which suggests one may influence the other. In this case, there is evidence that individualized audio-tutorial classes enhance the achievement levels of minority students in college biology classes.

The lower achievement levels demonstrated by the conventional class and the conventional class with Gowin's "V" may indicate the ineffectiveness of these formats. However, it also may indicate that in-depth experience and practice with Gowin's "V" are necessary by teachers and students before achievement levels improve. Novak (1980) has identified in his work with the "V" three different areas for its use. He has examined it as a pre-teaching, teaching, and learning tool. After implementing this format for several years, a study may show Gowin's "V" as an effective teaching-learning tool for minority students in biology classes.

The audio-tutorial mode of instruction is costly for small, minority colleges; however, based on findings in this study, A-T instruction may be cost accountable in terms of improved achievement levels. It may be worth the expense to implement and to expand audio-tutorial instruction in several other content areas for black college students. Furthermore, consortia of small colleges such as the Alabama Center for Higher Education could mutually develop audio-tutorial packets. These packets, distributed throughout the consortium, would provide appropriate instructional materials in a tested format to many minority students at minimal costs to the individual institution.

REFERENCES

Cobb, B.C. "The Effectiveness of the Audio-Tutorial Method of Instruction for Freshman Non-Science Majors." Unpublished Ph.D. dissertation, Purdue University, 1977.

Kahle, J.B.; Douglass, C.B.; and Nordland, F.H. "An Analysis of Learner Efficiency When Individualized and Group-Instructional Formats Are Utilized with Disadvantaged Students." *Science Education* 60 (1976):245–250.

McDaniel, E.D.; Guay, R.; Ball, L.; and Kulloff, M. "Spatial Experience Questionaire." West Lafayette, Indiana: Department of Education, Purdue University, 1978.

Novak, J.D. "The Application of Psychology and Philosophy to the Improvement of Biology Teaching." *American Biology Teacher* 41 (1979):466.

Novak, J.D. *Handbook for the Learning How to Learn Program.* Ithaca, New York: Cornell University, 1980.

Oltman, P.K.; Raskin, E.; and Witkin, H. "Group Embedded Figures Test." Palo Alto, California: Consulting Psychologists Press, 1971.

Peterson, R.W., and Carlson, G.R. "A Summary of Research in Science Education." *Science Education* 63 (1979):495.

Rotter, J.D. "Generalized Expectancies for Internal versus External Control of Reinforcement." *Psychological Monographs: General and Applied* 80 (1966):1–28.

Russell, J., and Hollander, S. "A Biology Attitude Scale." *American Biology Teacher* 32 (1975):270.

An Investigation of Factors Affecting Biology Achievement of Minority College Students

Mildred A. Collins

. . . the findings of this study support the studies of Russell (1975), Hubbard (1974), and other researchers (Lao, 1970; Kahle, et al., *1976; and Rowe, 1974). Cognitive learning styles, locus of control orientations, and attitudes toward biology all affect the achievement levels of introductory biology students.*

Introduction

Many factors affect achievement of college biology students. The ones investigated in this study are: (1) the cognitive learning style of students, (2) students' views of their environment, and (3) students' attitudes toward biology.

Cognitive learning style is the manner in which an individual perceives and processes data in his/her environment. It can be measured along a continuum with extremes defined as field-independent and field-dependent. Field-independent (FI) learners are characterized as analytical and usually are able to reorganize discrete fields and infer generalizations from reasonable evidence (Witkin, *et al.*, 1977). On the other hand, field-dependent (FD) learners are viewed as less able to locate a simple figure in a distracting or complex field. They are described as global thinkers, considering problems in their entirety rather than reorganizing these problems into parts for solutions (Douglass, 1979; Douglass and Kahle, 1977). Field-dependent students need greater external structure in the learning process for definition of their attitudes and judgments.

Another factor that may affect the way students learn was described by Rotter in 1966. His study focused on the degree to which individuals believed that they (rather than someone or something in their environment) were responsible for what happens to them. He called this personality dimension locus of control. Individuals who believe that they control their own fate score low on measures of locus of control and are termed internal. Internally oriented people believe that both situations and rewards are under their control. They are more likely to attempt to control their environments; they often show overt striving for achievement. Lao (1970) reported that they resist the influence of others, yet, in turn, are more effective in influencing others. Rowe (1978) found that internal students are more active information seekers and more effective information retainers. Individuals who believe that their fate is not under their personal control, but rather that it is controlled by powerful others or luck, are called external (Rotter, 1966). They are suspicious of authority figures and peers, and they believe that others may possibly block their attempts to control their environment. They accept short term gratification of their goals and place responsibility for their successes and failures elsewhere (Joe, 1971). Rowe (1978) found that external individuals are passive problem solvers. Further, she indicated that their achievement patterns in school were usually below the level predicted by standardized measures of their abilities.

Students' perceptions of their environments and their learning styles may influence their attitudes toward a particular course. Russell and Hollander (1975) indicated that attitudes correlate positively with achievement in most cases. This is consistent with findings by Hubbard (1974) that correlations occur between attitude and achievement in biology. Various researchers (Lao, 1970; Russell and Hollander, 1975; Kahle, *et al.*, 1976; Rowe, 1974; Douglass and Kahle, 1977) have noted intercorrelations between two or more of the following variables: achievement, locus of control, cognitive style, attitude, and mode of instruction.

This study was designed to examine possible intercorrelations between the above variables. It was conducted with introductory biology students attending a small, urban, southern, church-related college. The following questions were investigated:

1. Will field-independent students demonstrate greater achievement in a college biology course than field-dependent students?
2. Will students who are more internal on the locus of control measure achieve higher in a college biology course?
3. Will positive attitudes toward biology result in greater achievement in a college biology course?

Methods

The subjects for this study were 47 males and 46 females randomly selected from 150 minority students enrolled in a general biology course. Each week, the students were required to complete a two-hour laboratory exercise. These laboratory exercises contained specific objective statements, specific activity assignments listed in a step-by-step order, and review questions. The students were required to complete written reports on each laboratory exercise. In addition, study guides and texts were utilized. Each study guide included behavioral objectives, suggested learning activities, and library references which complemented the lecture topics.

Achievement tests were administered for each learning unit during the semester. Each achievement test consisted of 40 criterion-referenced, multiple-choice items selected from a test bank accompanying the text, *Biology* (Arms and Camp, 1979). These tests were administered immediately after each unit. A 112-item test was administered during the final examination period at the end of the semester. This final examination followed the same format as the achievement tests.

Cognitive learning style was assessed using the Group Embedded Figures Test (GEFT) (Oltman, *et al.*, 1971). This instrument is an 18-item 12-minute test which requires the student to identify simple figures hidden in a complex field. The test is an indicator of the student's analytical ability.

Locus of control was assessed by the Rotter Internal/External (I/E) Scale (Rotter, 1966), a 29-item forced-choice test (six of the 29 items are fillers). The test identifies differences in whether or not individuals believe they control, or are controlled by, their environment. Scores are determined by adding the number of external choices for each student (Rotter, 1966). High scores indicate external students, and low scores reflect an internal dimension.

The Biology Attitude Scale, composed of 22 Likert-type items, assessed attitudes toward biology (Russell and Hollander, 1975). This test was administered twice, once prior to the treatment period and once at the end of the semester.

Results and Discussion

Table 4.12 summarizes the correlations between final examination scores, final grades, and selected variables such as GEFT scores, I/E scores, and attitude scores. Highly significant correlations between attitudes after treatment and final examination scores, as well as attitudes after treatment and final grades, are shown in Table 4.12. This is consistent with Hubbard's (1974) findings that correlations occur between positive attitude and high achievement in biology.

As Figure 4.3 illustrates, only 32 students ($N = 92$) scored below the mean ($\overline{X} = 8.6$) on Rotter's measure of locus of control scale. On this measure, a low score indicates an internal orientation. The majority of the students scored above the mean and are, therefore, classified as external. Table 4.12 shows a significant, positive correlation between locus of control score and biology achievement as assessed by the final examination and the final grade. This positive correlation may be attributed to using carefully controlled and sequenced instructional materials; to the instructor's personality, which encouraged externals to believe they could achieve; or to the unusual distribution of the sample.

TABLE 4.12

Pearson Product Moment Coefficients between Selected Measures and Final Achievement in Biology

Selected Measures	I/E	GEFT	Pre-Attitude	Post-Attitude
Final Exam	.246* (91) p = .009	.325* (91) p = .001	.208* (91) p = .02	.481* (91) p = .001
Final Grade	.309* (92) p = .001	.291* (92) p = .002	.093 (92) p = .18	.424* (91) p = .001

KEY: I/E = Rotter Internal-External Scale (Rotter, 1966); GEFT = Group Embedded Figures Test (field independent/field dependent); * = Significant correlation; ( ) = N.

Implications

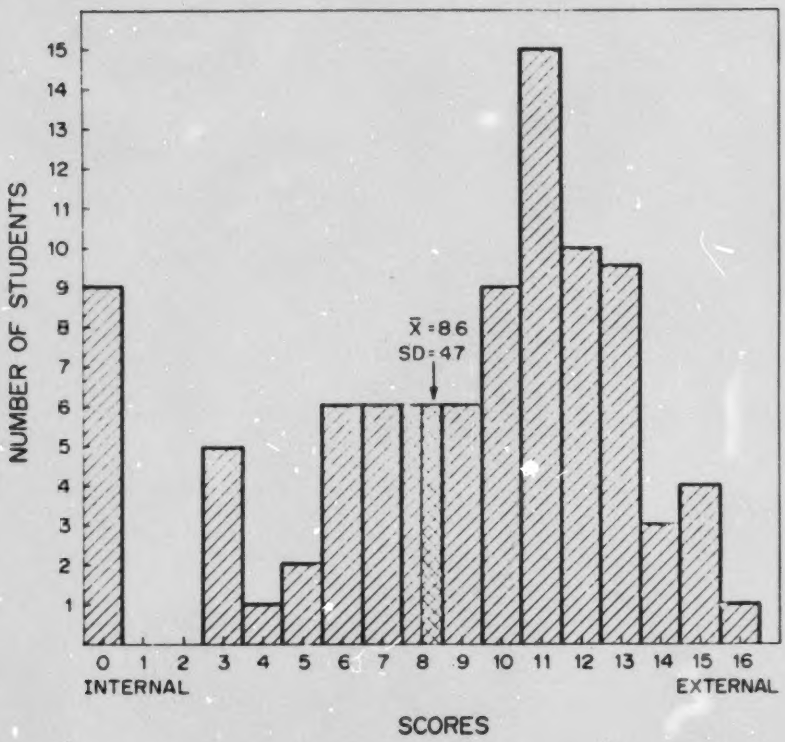
The analysis of the data implied that certain personal characteristics may influence learning achievement in an introductory biology class. Learning styles, perceptions of the environment, and attitudes toward biology were the variables studied.

Cognitive learning style, particularly field independence, was related to higher scores on a final exam as well as higher final grades in the course. According to this study, the GEFT scores correlated with achievement in biology. Anthony and Sanders (1981) found that GEFT scores correlate with the Otis-Lennon Mental Ability Test and the School and College Aptitude Test scores. Their findings also indicate that GEFT may be used to estimate the academic achievement of minority college students in introductory biology. Thus, by administering GEFT to biology students at the beginning of the semester, instructors can identify field-dependent and field-independent learners. This classification, then, could assist instructors in identifying students who may need extra help or a different mode of instruction.

Positive, significant correlations were found between locus of control (IE) scores and final examination scores as well as final course-grades. The hypothesis that internally oriented students achieve at higher levels was not supported by this result. Students who were classified as external achieved higher in this

FIGURE 4.3

Sample Distribution of Student Scores on the Rotter's I/E Scale



study. Sherris (1980) notes that teacher-directed learning can enhance the achievement levels of external students.

The third question addressed was whether positive attitudes correlate with achievement. This study indicates a positive correlation between post-experimental attitudes and final examination scores and final course grades.

In summary, the findings of this study support the studies of Russell and Hollander (1975), Hubbard (1974), and other researchers (Lao, 1970; Kahle, *et al.*, 1976; and Rowe, 1974). Cognitive learning styles, locus of control orientations and attitudes toward biology all affect the achievement levels of introductory biology students.

REFERENCES

Anthony, N.R.; Sanders, O.H; and Kahle, J.B. "An Investigation of Ability/Aptitude, Personal, and Social Characteristics of Black College Students." *Journal of Negro Education,* 50 (1981):346-353.

Arms, K., and Camp, P.S. *Biology.* New York: Holt, Rinehart, and Winston, 1979.

Cross, K.P. "Beyond Education For All—Toward Education for Each." *College Board Review* 99 (1976):5-10.

Douglass, C.B. "Making Biology Easy to Understand." *American Biology Teacher* 41 (1979):277-281, 298.

Douglass, C.B., and Kahle, J.B. "The Effect of Differentially Sequenced Individualized Instructional Materials on Student Achievement in Biology." *Journal of Research in Science Teaching* 14 (1977):335-340.

Hubbard, L.R. "The Effect of Audio-Tutorial Introductory Biology on the Attitude and Self-Concepts of Prospective Elementary Teachers." Unpublished Ph.D. dissertation, Purdue University, 1974.

Joe, V.C. "Review of the Internal-External Control of Construct as a Personality Variable." *Psychological Reports* 28 (1971):619-640.

Kahle, J.B.; Nordland, F.H.; and Douglass, C.B. "An Analysis of an Alternative Instructional Model for Disadvantaged Students." *Science Education* 60 (1976):237-243.

Lao, R.C. "Internal-External Control and Competent and Innovative Behavior among Negro College Students." *Journal of Personality and Social Psychology* 14 (1970):263-270.

Oltman, P.K.; Raskin, E.; and Witkin, H. "Group Embedded Figures Test." Palo Alto, California: Consulting Psychologists Press, 1971.

Oltman, P.K.; Raskin, E.; and Witkin, H. *A Manual for the Embedded Figures Test.* Palo Alto, California: Consulting Psychologists Press, 1971.

Rotter, J.B. "Generalized Expectancies for Internal versus External Control of Reinforcement." *Psychological Monographs: General and Applied* 80 (1966):1-28.

Rowe, M.B. "Relations of Wait Time and Rewards to the Development of Language, Logic and Fate Control." *Journal of Research in Science Teaching* 11 (1974):291-308.

Rowe, M.B. *Teaching Science as a Continuous Inquiry: A Basic.* New York: McGraw-Hill, 1978.

Russell, J., and Hollander, S. "A Biology Attitude Scale." *American Biology Teacher* 37 (1975):270-273.

Sherris, J.D. "The Effects of Instructional Organization and Selected Individual Difference Variables on the Meaningful Learning of High School Biology Students." Unpublished Ph.D. dissertation, Purdue University, 1980.

Witkin, H.A.; Moore, C.A.; Goodenough, D.R.; and Cox, P.W. "Field-Dependent and Field-Independent Cognitive Styles and Their Educational Implications." *Review of Educational Research* 47 (1977):1-64.

The Efficacy of Spatial Ability and Other Selected Measures in Predicting Mathematics Achievement of Minority Students

Gwendolyn Wilson Davis

An analysis of several factors, both general (locus of control, cognitive style, and gender) and specific (spatial experiences, spatial ability, and mathematics anxiety), which affect achievement levels of students in mathematics classes indicated the appropriateness of selected instruments for minority students. The spatial ability sub-test of the Spatial Experience Questionnaire was the most useful one.

Introduction

College mathematics instructors frequently attempt to identify characteristics which affect students' achievement in mathematics (Fennema and Sherman, 1978; McDaniel and Guay, 1976; Wheatley and Wheatley, 1979). McDaniel, *et al.*, (1978), for example, developed and used a two-part questionnaire to measure subjects' participation in spatial experiences, to analyze their enjoyment of these experiences, and to assess subjects' spatial abilities. The investigation reported in this paper sought to ascertain whether or not the number and enjoyment of spatial experiences and the amount of spatial ability possessed by minority students were related to other selected cognitive and personal variables.

Experimental Design

The students involved in the study matriculated at a small, private, predominantly black, four-year, liberal arts college in the South. Sixty-eight students (55 females and 13 males) participated in the study. Although the majority were freshmen, sophomores, juniors, and seniors were involved also. Prior to registering for the first semester, all freshmen were given diagnostic tests, developed by the college faculty, to assess their mathematics and communication skills. On the basis of the results, the freshmen students were enrolled in a particular section of introductory mathematics or in calculus. Consequently, students involved in this investigation were enrolled in the first semester of a low ability, introductory mathematics course or in a calculus course. Demographic data were obtained using a 26-item questionnaire developed by a group of black faculty members from five predominantly black, southern colleges and universities.

Instruments

The Spatial Experience Questionnaire (SEQ) (McDaniel, *et al.*, 1978) was used to assess both participation in and enjoyment of spatial activities as well as to assess the degree of spatial ability. The SEQ measure consists of 61 items. The first 25 measure number of spatial experiences; items 26 through 50 assess enjoyment of spatial activities; items 51 through 54 assess spatial ability. The last seven items interpret mathematical differences due to gender and were not administered due to the few males in the group. When total score is used in the analyses, items 1 through 50 (3 points each) are used. The Mathematics Anxiety Rating Scale was used to measure the degree of apprehension experienced by students placed in situations involving a high level of anxiety. The Rotter Internal/External (I/E) Scale (Rotter, 1966) was used to determine an individual's position along an internal/external continuum called locus of control. The subjects' cognitive styles were assessed using Witkin's Group Embedded Figures Test (GEFT) (Oltman, *et al.*, 1971).

Semester course grades were determined by calculating a weighted mean, using percentages established at the beginning of the semester for scores received on quizzes, hour examinations, homework assignments, laboratory exercises (introductory mathematics students only), and the final examination.

TABLE 4.13

Background Data in Percentages (N = 68)

				Parent Education			Community Size	
Student Age (16-18)	Student Sex (Female)	Work Hours per Week (<5)	Number of Siblings (≥4)	≤High School Graduate	Some College	College Graduate	<25,000	>200,000
94	80	54	60	39	25	36	38	38

Results

The demographic data describing the subjects in this study are presented in Table 4.13. Mean scores for the various measures used in the study are displayed by gender in Table 4.14. The Pearson Product Moment Correlation coefficient matrix in Table 4.15 shows total SEQ scores correlated significantly with scores on GEFT, indicating students who were more field-independent had had more spatial experiences which they had enjoyed. According to Table 4.15, total SEQ scores correlated negatively with course grades, suggesting the number and enjoyment of spatial activities were inversely related to higher achievement in the two mathematics classes.

TABLE 4.14

Mean Score for All Measures and Course Grade by Gender

	I/E (23)	GEFT (18)	SEQ (150)	Spatial Ability (8)	MARS (490)	Course Grade (4)
Female						
N = 55	10.7	4.3	53.4	4.4	215	1.3
Male						
N = 13	11.4	5.0	54.5	4.4	228	1.1

KEY: ( ) = Total Possible points; Grade Scale: A = 4, B = 3, C = 2, D = 1, F = 0; I/E = Locus of Control; GEFT = Group Embedded Figures Test; SEQ = Spatial Experience Questionnaire (items 1 through 50); MARS = Mathematics Anxiety Rating Scale.

Other significant correlation coefficients were found between the subscore which assessed spatial ability and the test for mathematics anxiety, the internal/external scale, and the final course grade. These significant correlations indicate that, in this sample, students with low scores on a spatial ability test had higher levels of math anxiety; that internal subjects scored higher than external subjects on a mathematics ability test; and that subjects with higher scores on a test of mathematical ability achieved higher grades in two mathematics courses. The matrix displayed in Table 4.15 does not show significant correlations between other variables such as locus of control, cognitive style, and course grades.

TABLE 4.15

Pearson Product Moment Correlation Coefficients For Selected Variables

	SEQ Total	Spatial Ability	MARS	I/E	GEFT
MARS	.0264 (63) p = .419	− .2523 (65) p = .021*			
I/E	− .0192 (62) p = .441	− .2037 (63) p = .055*	.004 (63) p = .199		
GEFT	.2726 (58) p = .019*	.0845 (59) p = .262	− .0611 (56) p = .319	− .1261 (55) p = .180	
Course Grade	− .2968 (63) p = .009**	.2134 (66) p = .043*	− .1046 (61) p = .211	.0126 (61) p = .461	− .0204 (58) p = .440

KEY: * = Significant at .05 level; ** = Significant at .01 level; ( ) = Number of subjects.

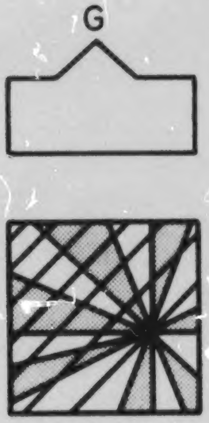
Discussion

There were no significant differences between the performance of females and males as indicated by mean scores on the instruments used in this study. The sample may be described as field-dependent with external locus of control orientations, lower than mid-range mathematics anxiety levels, low total SEQ scores, low spatial ability indices, and low levels of mathematical achievement in two courses at a minority college.

Spatial ability scores were correlated with achievement as measured by course grades in both mathematics courses. Total SEQ scores were not correlated with achievement. As expected, the number of spatial experiences and the enjoyment of these experiences correlated with high spatial ability scores. Although the field-independent mode of cognitive style correlated with the number and enjoyment of spatial experiences, the spatial ability index was not correlated with the field-independent mode of cognitive style. In Oltman, *et al.*, (1971), it was stated that the Group Embedded Figures Test did not assess spatial ability; these results corroborate that statement. However, students who

FIGURE 4.4

Illustration of a Group Embedded Figures Test Item*



Find Simple Form "G"

*P.K. Oltman, E. Raskin, and H.A. Witkin, "Group Embedded Figures Test." Palo Alto, California: Consulting Psychologists Press, 1971.

have had more spatial experiences and who have enjoyed them score higher on the GEFT. An examination of a sample item on the GEFT (Figure 4.4) indicates that activities thought to augment spatial perceptions might help a student complete the GEFT successfully. Locus of control orientation correlated significantly with spatial ability (Table 4.15). However, this dimension did not correlate with spatial experiences and the enjoyment of those experiences (Table 4.15). The negative correlation between spatial ability scores and locus of control orientation indicates that the internally oriented portion of the sample scored higher on the test of mathematical ability.

The significant negative correlation between mathematics anxiety scores and spatial ability scores indicate that subjects with more evidence of spatial abilities had lower levels of math anxiety. There was no relationship between anxiety levels and total SEQ scores. These results indicate that high mathematics anxiety may be positively related to lack of spatial ability rather than to the lack of spatial experiences.

This investigation found significant correlations between the following pairs of variables:

1. Cognitive style and number and enjoyment of spatial experiences
2. Course grade and number and enjoyment of spatial experiences
3. Mathematics anxiety and spatial ability
4. Locus of control orientation and spatial ability
5. Course grade and spatial ability.

Equally important is the fact there were no significant correlations between the following pairs of variables:

1. Course grades and mathematics anxiety
2. The number and enjoyment of spatial experiences and mathematics anxiety.

Implications

The results of this study are interesting both in the direction of significant correlations and in the comparison of mean scores by gender. For example, although the sample was not evenly divided by gender, data did not indicate higher levels of mathematics anxiety in minority females. In addition, both sexes reported approximately the same total number and the same degree of enjoyment of spatial experiences, and the mean scores on the subscale which measured mathematical ability were identical for males and females.

The correlations showing relationships between selected variables may be grouped to ascertain the effectiveness of these measures for minority students. The mean score of all items on the Spatial Experience Questionnaire, which indicates number and enjoyment of spatial experiences, did not correlate with course grade or level of mathematics anxiety. A careful examination of the test, by its developer (E. McDaniel) and several black science and mathematics faculty at minority institutions, revealed that the Spatial Experience Questionnaire did not include enough activities common to minority students. Therefore, one implication of this study is that the acquisition or development of an instrument better suited to a minority student population is imperative. Based upon positive, significant correlations between spatial ability mean score and high course grade as well as upon the inverse relationship found between spatial ability mean score and math anxiety mean score, the subscale (items 52-54) may be useful to identify quickly spatial ability levels of minority college students prior to enrollment in mathematics courses.

With the exception of a negative, significant correlation between mathematics anxiety and spatial ability mean scores, no relationships were found between mean scores on the MARS tests and other scores. Again, inspection of the instrument revealed that its length and readability level probably affected the performance levels of this sample. This finding implies that an alternate measure of mathematics anxiety should be used in studies involving similar populations.

Summary

An analysis of several factors, both general (locus of control, cognitive style, and gender) and specific (spatial experiences, spatial ability, and mathematics anxiety), which affect achievement levels of students in mathematics classes indicated the appropriateness of selected instruments for minority students. The spatial ability sub-test of the Spatial Experience Questionnaire was the most useful one.

In addition, interrelationships between characteristics were revealed. Interestingly, the dimension of cognitive style did not correlate with measures of mathematics anxiety and spatial ability. However, scores on the locus of control measure did correlate significantly with both spatial ability and spatial experience mean scores. The inverse coefficients indicated internal students had higher spatial ability scores and more spatial experiences.

REFERENCES

Fennema, E., and Sherman, J. "Sex-Related Differences in Mathematics Achievement and Related Factors: A Further Study." *Journal for Research in Mathematics Education* 9 (1978): 189-203.

"Mathematics Anxiety Rating Scale." Fort Collins, Colorado: Rocky Mountain Behavioral Science Institute.

McDaniel, E.D., and Guay, R. "Spatial Abilities, Mathematics Achievement, and the Sexes." Paper presented at the annual meeting of the American Education and Research Association, San Francisco, 1976.

McDaniel, E.D.; Guay, R.; Ball, L.; and Kulloff, M. "Spatial Experience Questionnaire." Unpublished test. West Lafayette, Indiana: Department of Education, Purdue University, 1978a.

McDaniel, E.D.; Guay, R.; Ball, L.; and Kulloff, M. "A Spatial Experience Questionnaire and Some Preliminary Findings." Paper presented at the annual meeting of American Psychological Association, Toronto, 1978b.

Oltman, P.; Raskin, E.; and Witkin, H. "Group Embedded Figures Test." Palo Alto, California: Consulting Psychologists Press, 1971.

Rotter, J. "Generalized Expectancies for Internal versus External Control of Reinforcement." *Psychological Monographs: General and Applied* 80 (1966): 1-28.

Wheatley, C., and Wheatley, G. "Developing Spatial Ability." *Mathematics in School* 8 (1979): 10-11.

Urban Minority Student Characteristics Related to Achievement in an Introductory Biology Course

Barbara Small Morgan

The results of the investigation indicate that the achievement levels of southern, black, urban, junior-college students in an introductory audio-tutorial biology class were greater than achievement levels of students in a conventionally taught class. The mode of instruction, however, did not affect their attitudes toward biology.

Introduction

A broad spectrum of ages, achievement levels, motivational levels, and academic experiences commonly are encountered in urban junior-college classrooms. The diversity of the student population can be attributed partially to attempts at making higher education accessible to all. Factors affecting urban junior-college students include: family responsibilities, part-time or full-time employment, lack of college preparatory background, and a lack of supportive networks due to the fact that many students are the first of a family to attend college. Thus, attrition rates may be high, and the academic progress of those who continue in college may be slow or minimal.

Research shows an interaction between academic achievement, instructional mode, and student characteristics. Therefore, a diversity of students indicates the need for a variety of teaching methods. Research findings suggest that the audio-tutorial (A-T) model is a viable alternative to traditional science instruction for some students (Kahle, *et al.*, 1976; Cobb, 1977). Cobb (1977) has found that the A-T model, developed by S.N. Postlethwait of Purdue University, can be extended to address the needs of black students at an urban southern college. Geisert (1977) reports some disadvantages as well as some advantages of A-T instruction. However, the overall response to this instructional mode has been favorable.

The purpose of this study was to assess the general characteristics of southern, urban, junior-college, minority students and to evaluate the relative effectiveness of A-T biology instruction for these students. A modified A-T program was designed to provide an alternative to conventional lecture-discussion instruction in an introductory biology course.

Experimental Design

The audio-tutorial program used in this study was an adaptation of the program developed at Purdue University. Changes were made to ensure that the needs and characteristics of black, urban, junior-college students were met, that the necessary resources were available, and that the instructional mode was compatible with teacher preferences. Three changes in the standard audio-tutorial mode were made:

1. The students were scheduled to attend independent study sessions at specific times. General assembly sessions were structured to review and elaborate on the materials presented during the independent study sessions.
2. Subjective essay questions as well as objective test questions were used to provide opportunities for the students to practice and improve writing skills.
3. Final course grades were determined on the basis of actual points earned out of total points possible.

During this study, the effectiveness of the modified A-T program was assessed by comparing the academic performance of students in two groups: a traditional lecture-discussion group and an audio-tutorial group. Groups consisted of the students who registered for one of the two sections of an introductory biology class for science majors for one quarter. Analysis of variance of mean scores of the School and College Aptitude Test (SCAT) showed no significant differences between the two groups (Table 4.16). The two groups were assumed equivalent on the basis of this analysis.

Students in each group were exposed to the same subject matter by paral-

TABLE 4.16

One-Way ANOVA of Total SCAT Mean Scores by Treatment Groups

	Mean	Source	df	SS	MS	F Ratio	F Probability
Audio-Tutorial	43.00	Between	1	20.0	20.0	.065	.80
Lecture-Discussion		Within	7	2144.0	306.3		
		Total	8	2164.0			

leling course content and testing procedures. Scores on instructor developed post-tests, weekly tests, and the final examination were used to assess achievement.

While the effectiveness of the A-T method of teaching was the focus of the experiment, demographic data were collected and analyzed for four sections of introductory biology in order to characterize this sample of students and to compare them with other samples utilized as part of the total project. For

TABLE 4.17

Demographic Data for Urban Junior College Biology Students from Two Successive Quarters

Student Characteristic	N	% of Total Sample
Sex	38	
Female		71
Male		29
Community Type	38	
Rural		16
Small City		29
Disadvantaged Urban City		24
Advantaged Urban City		32
Parental Education	38	
Advanced Degree		13
College Graduate		13
Post High School		18
High School Graduate		34
Not High School Graduate		21
Family Size	38	
2 Children		26
3-5 Children		34
More than 5 Children		40
Work Hours/Week	33	
Less than 5		18
5-10		12
10-20		15
20-40		29
More than 40		15
Age	36	
16-21		63
22-25		29
26-35		8

example, Rotter's Internal/External (I/E) Scale (Rotter, 1966) was used to assess locus of control orientation. Cognitive styles were assessed using the Group Embedded Figures Test (GEFT) (Oltman, *et al.*, 1971). Students' attitudes toward biology were assessed with the Biology Attitude Scale (Russell and Hollander, 1975). The Spatial Experience Questionnaire (McDaniel, *et al.*, 1978) was used to measure the number and enjoyment of spatial experiences of students.

Results and Discussion

Table 4.17 reports the demographic data derived from four sections of introductory biology. Most of these students are female (71%); they come from diverse community types; and few have parents with college degrees (13%). They represent a broad spectrum of ages (16-35). Forty percent are from families with more than five children and 44% are employed 20 or more hours a week.

TABLE 4.18

Descriptive Statistics for Pre-Tests of Achievement, Attitude, Learning Style, and Spatial Experience

Test	TPP	N	$\bar{X}$	SD	R
Pre-Test	85	35	27.37	8.76	12-54
Pre-Attitude	110	34	65.85	27.50	10-104
Group Embedded Figures Test	18	23	4.91	3.85	0-14
Rotter's I/E Scale	23	16	9.44	4.30	0-16
Spatial Experience Questionaire	150	8	46.50	16.11	21-68

KEY: TPP = Total Points Possible; N = Number; $\bar{X}$ = Mean; SD = Standard Deviation; R = Range.

The mean scores from tests used to assess important student characteristics are found in Table 4.18. The mean score on the Group Embedded Figures Test ($\bar{X} = 4.91$) suggests these students are field-dependent. The mean score on the

Rotter I/E Scale ($\overline{X} = 9.44$) indicates that, in general, most of the students in this sample have locus of control orientations which are neither highly internal nor external.

The mean score ($\overline{X} = 46.50$) for the Spatial Experience Questionnaire suggests that the subjects have had few spatial experiences (McDaniel, *et al.*, 1978) and that they do not enjoy spatial activities. Achievement was measured by a one-way analysis of variance of post-test mean scores of the audio-tutorial and the lecture-discussion groups. A significant difference was found between the A-T group and the lecture-discussion group in favor of the audio-tutorial group (Table 4.19).

TABLE 4.19

One-Way ANOVA of Post-Test Mean Scores by Treatment Groups

	Mean	Source	df	SS	MS	F Ratio	F Probability
Audio-Tutorial	54.50	Between	1	708.15	708.75	13.65	0.003
Lecture-Discussion	38.75	Within	12	623.25	51.94		
		Total	13	13,320.00			

A one-way analysis of variance also assessed any differences in attitudes toward biology between the two instructional groups. The results indicated no significant difference in attitude between the two groups. Students taught by the A-T instructional mode did not score higher than students taught by the lecture-discussion mode. Therefore, in this sample, mode of instruction did not affect attitude but did enhance achievement.

Summary and Implications

The results of the investigation indicate that the achievement levels of southern, black, urban, junior-college students in an introductory A-T biology class were greater than achievement levels of students in a conventionally taught class. The mode of instruction, however, did not affect their attitudes toward biology. Further study of these instructional modes using a larger sample of the student population is needed to provide greater support as to which mode of instruction is suitable for a minority student population. Further research concerning the effect of demographic variables is also needed so that a more complete perspective of variables which affect student achievement may be developed.

REFERENCES

Cobb, B.C. "The Effectiveness of the Audio-Tutorial Method of Instruction for Freshman Non-Science Majors." Unpublished Ph.D. dissertation, Purdue University, 1977.

Geisert, P. "Individualized Instruction: Can A-T Meet the Challenge of the Future?" *American Biology Teacher* 39 (1977):51-52, 64.

Kahle, J.B.; Nordland, F.H.; and Douglass, C.B. "An Analysis of an Alternative Instructional Model for Disadvantaged Students." *Science Education* 60 (1976): 237-243.

McDaniel, E.; Guay, R.; Bali, L.; and Kulloff, M. "A Spatial Experience Questionnaire and Some Preliminary Findings." Paper presented at the annual meeting of American Psychological Association, Toronto, 1978.

Oltman, P.L.; Raskin, E.; and Witkin, H.A. "Group Embedded Figures Test." Palo Alto, California: Consulting Psychologists Press, 1971.

Rotter, J.D. "Generalized Expectancies for Internal versus External Control of Reinforcement." *Psychological Monographs: General and Applied* 80 (1966):1-28.

Russell, J., and Hollander, S. "A Biology Attitude Scale." *American Biology Teacher* 32 (1975):270.

REMARKS

Assisting women faculty at minority institutions through the total research and dissemination process was the major focus of the Purdue minorities and women's project. While the target population was women from the colleges which compose the Alabama Center for Higher Education (ACHE), one of the studies included in this monograph was conducted by a participant on the campus of Washington University in St. Louis, Missouri.

During the first summer's workshop, Sandra Taylor, formerly an instructor of sociology at Talladega College, was accepted for graduate studies at Washington University. To complete the full circle of advanced study skills, the original goal of the project, and to accomplish the objectives of the project, Taylor's study was implemented at Washington University. Subjects used in this study were selected from the Washington University student population.

The purpose of the study performed by Taylor was to predict students' locus of control orientation based on their classroom verbal behavior patterns. Since the sample population was not representative of a student population for minority institutions, inferences were not made to students at the ACHE institutions. However, this study is included in the monograph because it reflects the success of the project in training minority women in investigating research problems, presenting papers at national conventions, and preparing papers for publication.

Classroom Verbal Behavior Patterns as Indicators of Locus of Control Orientation

Sandra Taylor

Although it was not possible to show that classroom verbal behavior is an indicator of a person's locus of control orientation, this study suggests that it may be a better predictor for males.

Introduction

The locus of control construct has received increasing attention over the past few years. Studies indicate that one's locus of control orientation may have considerable impact on one's behavior (Lefcourt, 1976; Phares, 1976). The dimension of locus of control describes an orientation along a continuum from internal to external. Individuals are described as internal if they believe they control their own destiny rather than being controlled by some outside force. On the other hand, individuals who believe their lives are controlled by outside forces are described as external (Rowe, 1978a).

Internally oriented persons are more likely to exercise control over their lifestyles than externally oriented persons. Therefore, internal individuals endeavor to control life's occurrences. For example, internally oriented students preparing for an examination probably exert more conscientious efforts in studying. In addition, they may contribute more during class, asking questions and seeking verification of their ideas.

Usually, external individuals do little to shape the course of their lives. Externally oriented students may prepare less for tests, believing that the outcome of an examination is contingent upon factors other than their preparation. Using the same reasoning, external individuals may not think that it is worthwhile to ask questions or to seek clarification through classroom discussions. One's classroom behavior pattern may serve as an indicator of one's locus of control orientation.

In this study, locus of control orientation was viewed as existing along a continuum from internal to external. Because a positive reinforcer tends to strengthen the potential for a certain behavior among internal individuals (Rotter, 1966) and since class participation was one of the criteria for the student's grade, it was hypothesized the internal individuals would contribute more frequently and more extensively to class discussions.

Methods and Materials

The purpose of this study was to identify locus of control orientation by observing verbal classroom behavior and to validate the observed orientation with the adult Nowicki-Strickland measure. The rationale for this was if instructors could quickly and reliably assess a student's locus of control orientation, they could use more appropriate instructional strategies. This study was implemented to ascertain any possible relationships between classroom behavior patterns and locus of control orientation. First, appropriate criteria were established, then a limited case study format was used to observe and record behaviors. The following hypotheses were investigated:

1. The higher the degree of internality, the more responses a student will make during a class; and

2. The higher the degree of internality, the longer the response a student will give.

Initially, the verbal behaviors for 15 students enrolled in a college-level sociology class were recorded. These verbal behaviors were recorded according to the following categories:

1. Number of questions asked (query soliciting information before lecture or presentation)
2. Voluntary response (comment and/or question following lecture or student presentation)
3. Fluency of comment (compound sentence without pause(s) and the use of "uh's" and "ah's")
4. Assignment remarks (positive feedback or approval after an assignment was made by the instructor)
5. Response quality (statement initiating responses from more than one other student simultaneously).

When one of the above listed behaviors occurred, a notation was made in the appropriate category for the student demonstrating the behavior. This log of verbal behaviors was kept over 12 one-hour class sessions. Tape recordings of the communications during the class sessions were made also and served as a check of the written log. Each student's verbal behavior was described by the number and variety of patterns noted during the 12 class sessions. These observations were quantified by assigning points to each internal behavior and by deriving point totals.

Next, the adult Nowicki-Strickland scale,[1] a measure commonly used to ascertain an individual's locus of control orientation, was administered to all students. The Nowicki-Strickland scale ascertains an individual's locus of control orientation based on his/her response to specific questions. The student's locus of control score was correlated with the quantitative observational score. Due to operational problems similar to those explained by Rotter (1976), significant correlations between the Nowicki-Strickland scores and the recorded observations were not obtained. Yet, these analyses indicated that verbal behavior within the classroom might be an indication of a student's locus of control orientation. Therefore, the study was redesigned, and a limited, in-depth case study was implemented.

The revised procedure included only six subjects, selected on the basis of their observed verbal behavior patterns. Total response score was used to select the subjects. The sample consisted of the two students (one male, one female) having the highest score, the male and female students having the lowest score, and the male and female students having the median number of points. These pairs were designated as external, internal, and medium respectively. Although the original tape-recorded communications and the anecdotal log were analyzed more extensively, new observations were made under two fairly controlled classroom situations. During lecture sessions, the instructor presented information, and student verbal interactions consisted of direct questions. Other class periods involved student presentations, during which students reported on their own specific projects.

During both sessions, records were kept of two aspects of verbal behavior: number of responses and length of responses. The total number of student responses made during lecture sessions constituted one data source. Length of response was categorized as short (one sentence) or long (more than one sentence). Length-of-response data were collected on the first direct question asked after a student presented his or her project. Content, accuracy, or elaboration of response was not studied.

Results

The efficacy of the observational data to identify locus of control orientation is provided in Table 4.20 and graphed in Figure 4.5. The expected pattern, that is, more and longer verbal responses indicative of an internal locus of control, was found in the three male subjects. These subjects were distributed along the Nowicki-Strickland scale. However, the expected pattern was not

TABLE 4.20

Comparison of Nowicki-Strickland Assessment with Number and Length of Response

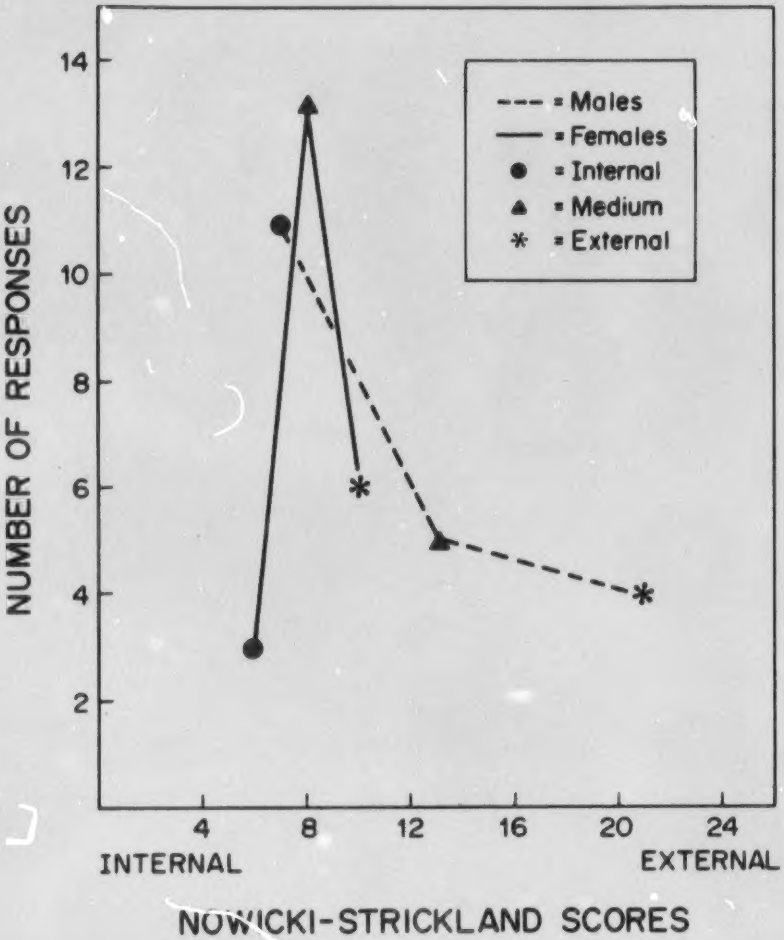
	Nowicki-Strickland*	Number of Responses	Length of Response*
Male			
Internal	7	11	> one sentence
Medium	13	5	≤ one sentence
External	21	4	≤ one sentence
Females			
Internal	6	3	≤ one sentence
Medium	8	13	> one sentence
External	10	6	> one sentence

KEY: ≤ 1 sentence = short response; > 1 sentence = long response.

*The lower the number, the more internal the students.

FIGURE 4.5

Relation of the Number of Responses to the Locus of Control Orientations of Six Selected Subjects



found among the female subjects. Although their verbal behaviors suggested internal, medium, and external orientations, their Nowicki-Strickland scores were clustered at the median (8.0). Among female subjects, observed verbal classroom behaviors were not indicative of locus of control orientations. The tape recordings and anecdotal logs were studied to explain these gender differences. These revealed that the most internal male was the most verbose of the three males in the study; that is, the internal male made more and longer responses when compared with the other two males in the study. Only the internal male asked consecutive questions after a lecture and interrupted a lecture either to ask a question or make a comment.

The internal female did not initiate any verbal behavior. The only responses made by this subject were involuntary, based on having the responsibility for discussing her project. The internal female appeared to be unique since she was the only subject remaining silent unless directly called upon. Thus, it appears that the internal female would not have contributed to class discussions at all if she had not been required to discuss her project.

The median scoring male appeared to be responsive only in cases of questions concerning his particular project. Not only were his responses involuntary, but they were also brief. The majority of his responses were monosyllabic "yes" or "no." Although the median male was less responsive than other subjects, he occasionally made voluntary contributions. On the other hand, it seems that little, if anything, would have kept the median female silent. The median female, in addition to exhibiting verbal behavior, tended to transform her responses into mini-lectures, lengthy and elaborate.

The external male's verbal behavior differed slightly from that of the median male. However, the external male made fewer responses and was shorter in his sample response than the other males. Although the external female made comments that evoked interest, her comments were always short and she did not elaborate on them. Other students, however, tended to expound upon her ideas which instigated several classroom discussions.

Implications

There have been studies of locus of control orientation and its relationship to academic achievement, to personal and social interactions, and to problem solving strategies (Joe, 1971; Phares, 1976; Rotter, 1966; and Rowe, 1978b). This research has attempted to identify student verbal patterns which may be indicative of locus of control orientation. If a simple observational procedure could be identified, instructors could use instructional strategies appropriate for internal or external students. The results of this study indicate that one's classroom verbal behavior does not necessarily serve as an indicator of one's locus of control orientation. In this limited sample, internal students were not always the most verbose or external students the most silent. Although it was not possible to show that classroom verbal behavior is an indicator of a person's locus of control orientation, this study suggests that it may be a better predictor for males.

This study indicates the need for expanded observations on the subjects. It is suggested that observations of the students in nonacademic settings, such as their dormitories and the student union, may be needed to supplement the classroom behavior data. In addition, further investigation might entail studying the nonverbal behavior of students in the classroom. These added observations may result in identifying a series of behaviors which indicate locus of control orientation and which are easily interpreted by college instructors.

NOTE

1. A copy of the Nowicki-Strickland scale is available from Dr. S. Nowicki, Emory University, Atlanta, Georgia 30322.

REFERENCES

Joe, V.C. "Review of the Internal-External Control Construct as a Personality Variable." *Psychological Reports* 28 (1971):619-640.

Lefcourt, H.M. *Locus of Control: Current Trends in Theory and Research.* Hillsdale, New Jersey: Lawrence Erdbaum, 1976.

Phares, E.J. *Locus of Control in Personality.* Morristown, New Jersey: General Learning Press, 1976.

Rotter, J.B. "Generalized Expectancies for Internal versus External Control of Reinforcement." *Psychological Monographs: General and Applied* 80 (1966):1-28.

Rotter, J.B. "Some Problems and Misconceptions Related to the Construct of Internal versus External Control of Reinforcement." *Journal of Consulting and Clinical Psychology* 43 (1976):56-67.

Rowe, M.B. "Science and Soul: Some Musings on Fate Control." In *Teaching Science as Continuous Inquiry: A Basic,* pp. 319-341. New York: McGraw-Hill, 1978a.

Rowe, M.B. "Externality and Children's Problem Solving Strategies." Unpublished report for the Department of Health, Education, and Welfare Grant #ROIMH25229, University of Florida, Gainesville, 1978b.

5 A Profile of Southern Minority Undergraduates

The 1977 assessment of science by the National Assessment of Educational Progress (NAEP) included, for the first time, items to measure attitudes. Analysis of these items has revealed an important contradiction: Groups that traditionally do least well on cognitive items—blacks, those living in urban-disadvantaged areas, and those living in the Southeast—show more favorable attitudes toward science classes and science as a career than do groups with higher cognitive scores on this and previous (1969, 1973) science assessments. —Jane Butler Kahle, 1980

Introduction

As the participants from the five cooperating colleges and the university became acquainted, they shared experiences, problems, and hopes concerning the education of their students. Each participant was actively involved in minority education in the sciences. Indeed, their lives and careers were witnesses to their dedication. During the initial summer's workshop, they were asked to analyze and to interpret findings, abstracted above, from the 1977 National Assessment of Educational Progress concerning minority achievement in and attitudes toward science. Many of their students were typical of the groups in which the pattern of low achievement and positive attitudes had been found. To interpret this anomaly and analyze factors affecting the science achievement of their students, they developed a survey to collect demographic data concerning undergraduate enrollees at southern minority institutions. In addition, they selected and agreed upon a battery of standardized measures which could be selectively used by each participant. Although each would use only the measures appropriate for her research (and acceptable on her campus), they all would administer an identical form of each construct. That is, if information concerning locus of control orientation was desired, Rotter's Internal/External scale would be used rather than another instrument such as the adult Nowicki-Strickland measure. Thus, the data collected would provide a base for comparison between institutions in the project as well as for other researchers. In addition, it was anticipated that this large scale characterization of southern minority students might yield insights which would enhance both student learning and administrative effectiveness at the cooperating institutions.

Demographic Data

One purpose of this project was to characterize a representative sample of undergraduate students at five southern minority colleges and universities so that their educational needs could be better met. The majority of the students were enrolled in introductory biology courses, while a smaller number were enrolled in mathematics and social science courses.

Demographic Survey

A demographic survey, presented in Appendix C, probed deeply into societal, familial, and personal characteristics of the students. Efforts were made to create a simple, yet reliable and valid survey instrument. Sensitivities of students, cooperating faculty, and institutional administrations were considered in the survey design. Standard descriptions of community type and of community size, developed by the Educational Commission of the States for their assessments of educational progress, were used. In addition, all responses were numerically coded in the same order from small to large, so that meaningful correlations could be computed.

It was agreed that the implementation of the survey as well as the utilization of standardized measures would be subject to both institutional and individual constraints. For example, several participants deleted the items related to religious preference and personal finance, and all subjects were instructed to delete any item which they felt invaded their personal privacy. Since all subjects did not complete the entire questionnaire, the number of responses for items varies.

Information collected by printed surveys is confounded by problems of completeness, accuracy, and interpretation. Although the participants (or experienced psychologists on the participant's campus) administered the survey and were available to answer questions, the results must be considered tentative and subject to error. For example, efforts were not made to ascertain accuracy of responses with institutional records. In addition, some responses relied on student memory (number of periodicals received weekly in home) or on student interpretation (socio-economic level of home community). Lastly, although a shorter version was field-tested at Miles College and Alabama A&M University during the preceding spring, the survey was an initial attempt by the participants to gather demographic data.

However, student responses provide a general description of the sample which includes socio-economic level of home community, population of home community, number of siblings, parental level of education, number of periodicals in the home, gender of student, choice of college major, number of previous science courses, and hours of student employment. The data, presented in Tables 5.1, 5.2, and 5.3, characterize the students at four of the participating institutions as well as the combined sample. Of the the total sample, 55% were females, while 45% were males. Of the total sample, 82% of the students were in the 16-21 age group, and 76% of them were freshmen or sophomores. Although 94% of these students worked at paid jobs while in college, 39% of them worked less than 5 hours per week. Data gathered on their family backgrounds indicated that 38% came from families with five or more siblings, that the majority of their parents (55%) had completed high school, and that 26% of their parents had completed college. In 36% of their families, both parents lived at home and both worked. About a third of the students came from communities under 25,000 and a third from cities over 200,000. Students selected descriptors (rural, disadvantaged urban, and advantaged urban) about equally to characterize their home communities.

Standardized Measures

Additional data were collected concerning aptitude, abilities, attitudes, cognitive learning styles, number and enjoyment of spatial experiences, levels of mathematical anxiety, and locus of control orientations. Again, the instruments, listed in Appendix D, were not used in all schools so the number of responses vary. Although the tests have been referred to in Chapter 4, a comprehensive description of them is a prerequisite for interpreting the information in this chapter.

Two measures of personality were studied, cognitive style and locus of control. Cognitive style was assessed by the Group Embedded Figures Test (GEFT), which identified "the extent of competence at perceptual disembedding" (Oltman, 1971). The test requires that the individual identify and trace simple figures embedded within complex ones. There is a total of 18 possible points. Individuals with high scores are considered field-independent (FI); those scoring low are classified as field-dependent (FD).

The personality dimension of locus of control was assessed by Rotter's internal-external (IE) scale. Rotter's scale was developed to determine an individual's orientation along a continuum referred to as locus of control. This scale has 23 items. Each item is composed of two statements; for example, (a) "What

TABLE 5.1

Demographic Data: Personal Characteristics of Southern Minority Students by Percent

	Sex		Age			Major					Work Hours				
Institution	M	F	16-21	22-25	26-35	Soc. Sci.	Hum.	Sci.	Educ.	Uncl.	Under 5	5-10	11-20	24-40	Over 40
1	47	53	82	13	7	23		10	31		56				
2	44	56	83	11	6	49	10	10	11	16	20	10	23	25	4
4	29	71	63	29	8	11	5	63	18	3	18	12	15	39	15
5	28	72	94			42	14	30			54	28			
Combined	45	55	82	13	5	41	9	18	18	13	39	13	18	19	5

KEY: Blank = Item not used or data not available.

TABLE 5.2

Demographic Data: Family Characteristics of Southern Minority Students by Percent

School	Family Size					Parental Education			Reading Materials			
	0	1	2	3-4	>5	<H.S.	H.S.	>H.S.	0	1	1-5	6-10
1				11	42	19	37	56		42		
2	10	13	14	23	41	22	34	41	4	25	43	21
4	5	19	17	14	36	21	34	45	8	21	39	24
5	3	14	25	35	25		39*		6	23	38	30
Combined	6	14	17	26	38	20	35	46	5	23	38	28

KEY: Blank = Item not used or data not available.

*Data combined to ≤ high school education.

happens to me is my own doing" and (b) "Sometimes I feel that I don't have enough control over the direction my life is taking." Each student responds by selecting the alternative s/he believes to be more descriptive of the student's own view. There are no right or wrong answers, and numerical values are arbitrarily assigned so that aggregate high scores imply an external locus of control orientation, while low scores reflect an internal locus of control orientation. The external orientation indicates that the person believes that rewards are contingent upon the behaviors of powerful others or fate. An internal orientation indicates that the individual believes s/he is in control of either the rewards or criticisms related to behavior.

TABLE 5.3

Demographic Data: Community Characteristics of Southern Minority Students by Percent

School	Under 25,000*	25,000 to 200,000	Fringes ≥ 200,000	Over 200,000
1	41	28	4	27
2	33	25	14	28
4	24	13	11	53
5	38	19	6	38
Combined	36	24	9	31

*Descriptors from National Assessment of Educational Progress

In addition to the GEFT and Rotter's IE scale, the School and College Aptitude Test (SCAT), Spatial Experience Questionnaire (SEQ), and Biology Attitude Test (ATT) were given to most subjects. The Math Anxiety Rating Scale (MARS) was administered on only one campus.[1]

The School and College Aptitude Test (SCAT) assesses the scholastic aptitude of an individual. A standardized test, which can be given at the pre-college or college level, it consists of verbal and quantitative subsections. The verbal section (SCATV) uses verbal analogy items to assess language understanding. The quantitative section (SCATQ) measures how well a student understands basic numerical operations by using comparison items. For example, some items involve a comparison of the magnitude of two mathematical quantities. According to the test manual, the quantitative items have been designed to place minimum emphasis on reading and to require quantitative understanding and insight, rather than to measure traditional computational skills. The test yields a verbal, quantitative, and total score. Each sub-section has a maximum of 50 points, making a total possible score of 100 points.

Another instrument used was the Spatial Experience Questionnaire (SEQ). It was developed as a screening tool to discern the number of spatial experiences and the extent of one's enjoyment of spatial experiences and to estimate one's spatial ability. The instrument is divided into four subsections, three of which were used. The first one asks the participant to rate on a scale of "never" to "very often" the extent of their participation in 25 activities such as sketching house plans, solving mathematical riddles, drawing/painting, and sewing/embroidering. The second section requires that the person rate, on the same scale, the amount of enjoyment they receive from each experience. The third section provides an estimate, according to the respondent's personal rating, of the ease with which the participant performs certain spatial tasks. For example, the third section of SEQ assesses spatial ability by analyzing competency to construct a mental map of a city, to manipulate mentally a mathematical equation, and to visualize the rotation of a cube. The maximum score for the first two sections is 150 points, and the ability section has a maximum score of 12 points.

Another instrument generally used was a Biology Attitude Test (ATT). The attitude test uses two different scales to gather information on students' attitudes toward biology. This measure had proved reliable with other samples of minority students. The first part of the instrument consists of 14 statements, expressing attitudes about biology. Respondents rate the statements according to the extent of their agreement or disagreement. Representative items state: "It makes me nervous to even think about doing a biology experiment" or "I feel at ease in biology and like it very much." Ratings range from "strongly disagree" to "strongly agree." The second part of this attitude measure is an eight-item differential scale that allows respondents to choose descriptive terms that express their feelings toward biology. The scoring procedure indicates the degree of positive or negative attitudes a person has toward biology, and again there are no correct answers. Arbitrarily high scores are indicative of positive attitudes toward biology.

Mean scores of total sample, actual range of scores, standard deviations, total possible points, and number of schools involved are recorded in Table 5.4. These data were used to answer questions concerning minority education in several ways. In some cases, the subjects were divided into categories based on the mean score for the entire sample. For example, the internally oriented sample (<9) was compared with the externally oriented sample (>10) by several personal, societal, and academic factors. In other cases, mean scores were compared with mean scores of comparable samples. Generally, however, the combined data collected from both the demographic survey and various standardized instruments provided a composite indication of personal, social, and academic attributes of southern minority college students.

TABLE 5.4

Mean Scores and Standard Deviations for Cognitive and Aptitude Tests

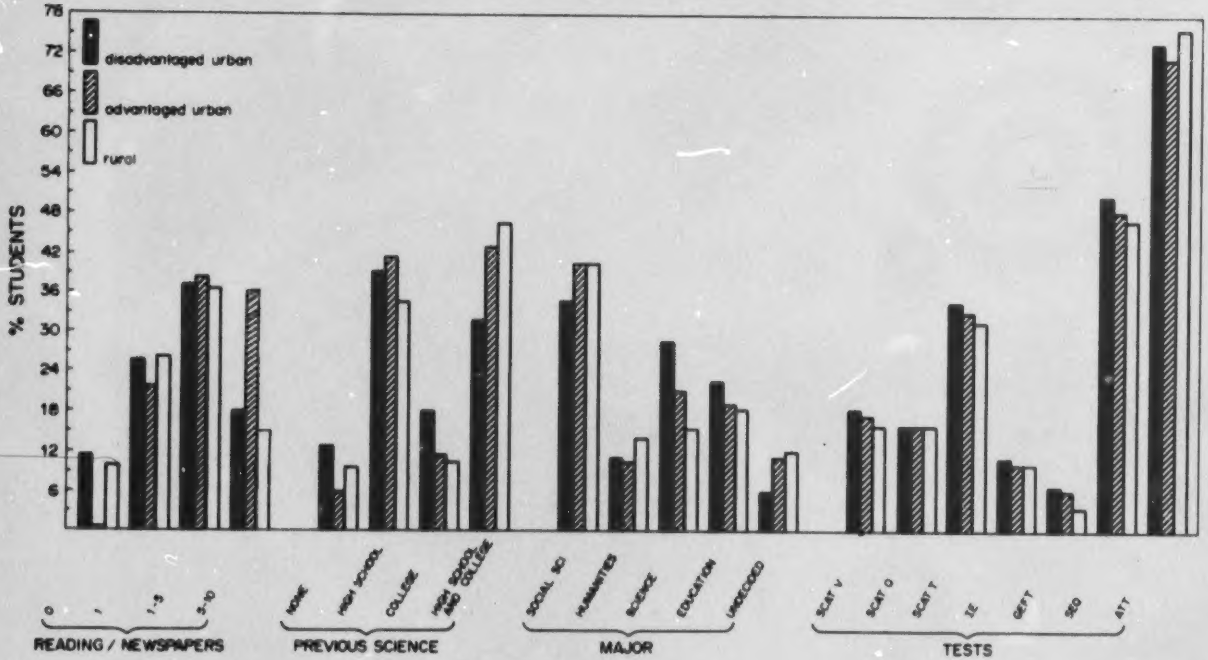
	$\overline{X}$	Range	SD	Total Possible Points	Number of Schools Involved
IE (N = 386)	9.98	0-23	3.8	23	5
GEFT (N = 374)	5.23	0-18	4.5	18	5
SEQ (N = 288)	47.40	2-99	18.3	150	2
ATT (N = 380)	74.60	0-110	17.9	110	5
SCATV (N = 242)	16.10	1-50	6.5	50	3
SCATQ (N = 242)	14.70	0-40	5.9	50	3
SCATT (N = 242)	30.80	0-90	10.7	100	3
OLMAT (N = 123)	31.01	8-65	12.4	80	1
MARS (N = 68)	219.00	98-324	7.4	490	1

Profile of Undergraduates

Both the demographic survey and the battery of standardized measures had a twofold purpose: to describe a sample of southern undergraduates at minority colleges and universities and to provide a basis for comparison of

FIGURE 5.1

Effects of Socio-economic Status on Selected Variables



KEY: Disadvantaged urban, N = 66; Advantaged urban, N = 117; Rural, N = 80.

individual school samples. The participants were particularly interested in the following questions:

1. What factors affect the selection of a college major?
2. What factors contribute to a student's personality dimension of locus of control?
3. Do personal, family, or social factors affect a student's cognitive style?
4. What is the effect of gender on achievement, enrollment in science courses, and selection of major?
5. Does the number of hours students work vary across these campuses? If so, how can academic programs be adjusted to better suit the needs of working undergraduates?

Answers to these as well as other dimensions of undergraduate southern minority science education were suggested by both the individual and collective data. Each participant has discussed her results in an earlier chapter; now we shall report the collective data.

Home Community

The results were tabulated by community type, a characteristic that reflects socio-economic status, to ascertain its relationship to the following variables: amount of periodical literature available in homes, previous enrollments in science courses, choice of college major, and mean scores on selected measures. Students selected the community type which best described the community in which they had attended high school. Figure 5.1 displays bar-graph descriptions of the sample by three community types: disadvantaged-urban, advantaged-urban, and rural. Using the *National Assessment of Educational Progress* (NAEP, 1979) descriptors, "disadvantaged-urban" (low income metropolitan) includes communities in or around cities with a population greater than 200,000 in which a high proportion of residents are on welfare or not regularly employed. "Advantaged-urban" (high income metropolitan) communities are described as those in or around cities with a population greater than 200,000 where a high proportion of the residents are in professional or managerial positions. "Rural" communities are defined as areas where the population is less than 25,000 and where most of the residents are farmers or farm workers.

As Figure 5.1 shows, regardless of community socio-economic level, most subjects had from one to five periodicals or newspapers available in their homes. In addition, the data in Figure 5.1 suggest that more southern minority students from rural schools have had science courses at both the college and high-school level than students from either advantaged or disadvantaged urban areas. Although 41% of the students who described their home communities as disadvantaged urban had taken science in high school, only 20% of them enrolled in science courses in college. Our data indicate that disadvantaged black students enroll in science in high school, but few continue in college. Two factors may contribute to this finding: usually only one science or mathematics course is required for high school graduation (NSF, 1980). Often students may select science, avoiding both fundamental and advanced courses in mathematics. The lack of mathematics courses effectively eliminates students from college science courses. Stake and Easley (1978), Ignatz (1975), and Kahle (1979) attribute low science enrollments among minorities to academic tracks which allow for little flexibility in high-school programs and to inadequate counseling of minority students. The largest percentage of subjects, regardless of community type, selected social science as their college major. Science majors comprise the next largest percentage of this sample. The dichotomy found in the 1977 *National Assessment of Educational Progress of Science* between attitude toward and achievement in science is reflected in our data. Students describing themselves from urban disadvantaged communities comprise the highest percentage selecting science as a major. This is in keeping with the NAEP results that showed that black 13- and 17-year-olds valued scientific studies and thought that careers in science were worth both the expense and the time involved (Kahle, 1979).[2]

The remaining data in Figure 5.1 illustrate mean scores on various standardized measures by community type. In the case of some measures, namely Rotter's Internal/External scale (IE), the Group Embedded Figures Test (GEFT), and the Biology Attitude Test (ATT), high mean scores do not reflect higher abilities or aptitudes. Rather, respectively, they indicate a more external locus of control, a more field-independent mode of cognitive style, and more positive attitudes toward biology. However, in other cases, such as the verbal, quantitative, and total mean scores of the School and College Aptitude Test (SCATV, SCATQ, and SCATTOT), higher mean scores indicate higher predicted levels of college achievement.

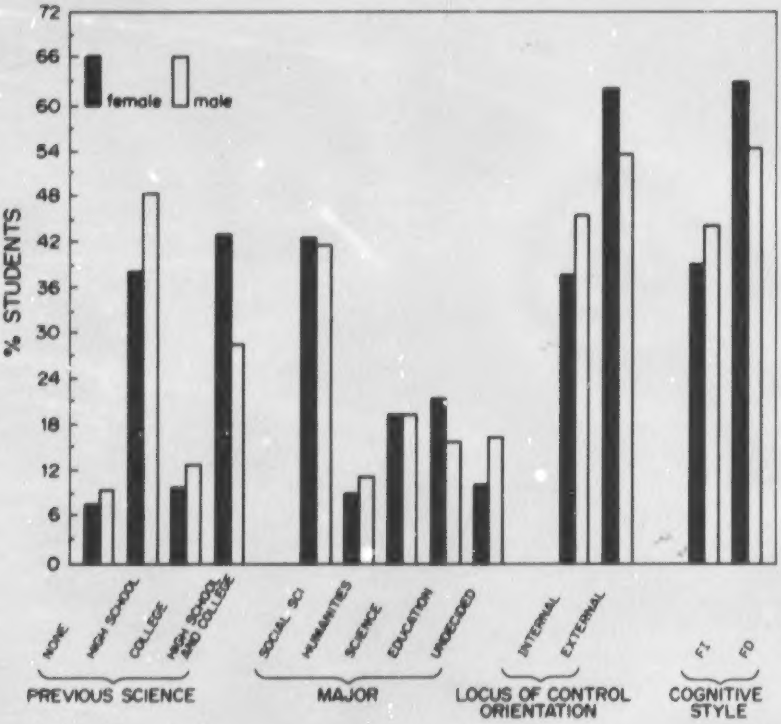
Although mean scores on selected tests do not differ significantly by community type, one pattern emerges. Among this sample of southern minority college students, subjects from disadvantaged urban areas have slightly higher mean scores on most of these measures than students from advantaged urban or rural communities. Although it could be argued that only the most able students from disadvantaged urban areas continue to college, two of the participating institutions, Miles College and Atlanta Junior College, have open admission policies and attract students mainly from urban areas. It has been suggested by Kahle (1979) that urban area compensatory educational programs for the disadvantaged may account for these slightly higher achievement levels. Our data corroborate that suggestion.

Gender Differences and Similarities

Figure 5.2 compares percentages of females and males by previous science experience, college major, locus of control orientation, and cognitive style. The data indicate that males take more high school science courses than females; yet equal percentages of men and women enroll as science majors. Perhaps, women in college are freer of the social and peer pressures which restrict their enrollment and performance in high school science courses (Vockell and Lobonc, 1981). In addition, only slight differences are noted between percentages of men

FIGURE 5.2

Percentages of Males and Females by Category



and women selecting specific college majors. In education, there is a noticeable difference; also a higher percentage of males have not decided on a major.

Differences are found, however, in locus of control orientation. Using the mean score of the total sample (10) on Rotter's IE scale to divide the subjects into two categories, internal (<9) or external (>10), 63% of the females have an external orientation, while 37% are internally oriented. On the other hand, 55% of the male subjects are externally oriented while 45% view themselves as internally controlled. These differences in percentages of males and females grouped according to locus of control orientation follow a previously noted pattern; that is, as a group, females tend to be more externally oriented than males (Phares, 1976; Feather, 1968).

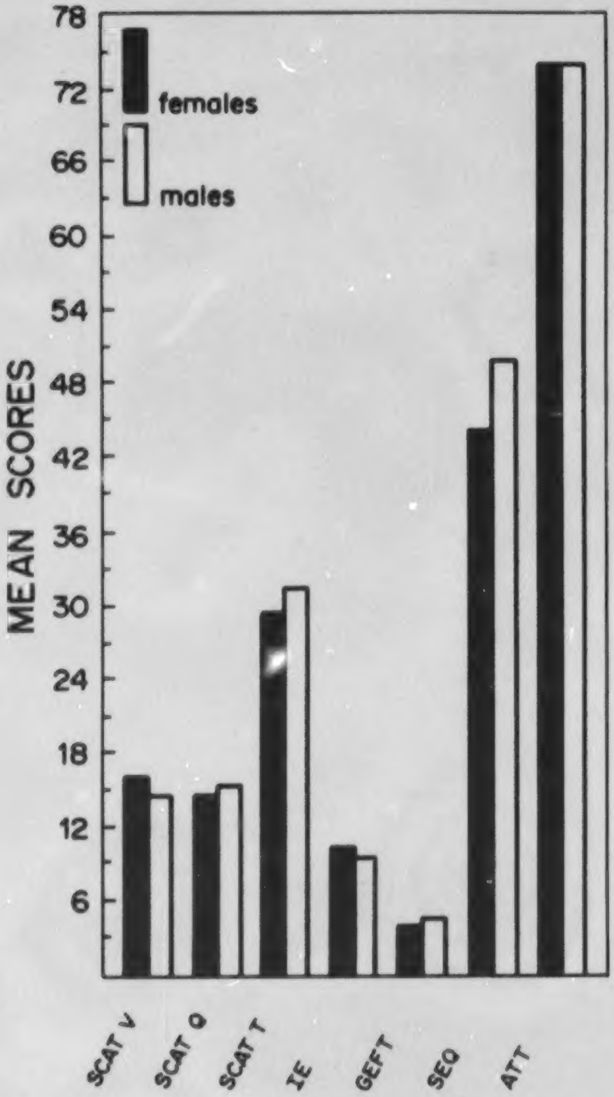
Students were also divided into two groups, field-independent and field-dependent, based upon the mean scores of the GEFT test of cognitive style. In this sample, subjects scoring at 5 and above were grouped as field-independent, while those scoring at 4 and below were categorized as field-dependent. Divided on this mean, 59% of the total sample was grouped as having a field-dependent cognitive style. When males and females are divided separately, a higher percentage of females (62%) than males (54%) are characterized as field-dependent. Although Witkin claims that "the difference in means between the sexes is quite small compared to the range of scores within each sex," he and other researchers have found that scores of male and female subjects form a bimodal distribution (Witkin, 1977, p. 7). According to Maccoby and Jacklin (1974), "it is well known that males tend to score higher than females on tests of 'field-independence' " (p. 104). They also state that this finding holds across measures of cognitive style. Our findings with a major sample of southern minority students support a gender difference in mode of cognitive style.

A further examination of Figure 5.2 shows a similarity between the percentages of males and females grouped according to locus of control orientation and to mode of cognitive style. In this sample, mode of cognitive style and locus of control orientation are significantly correlated ($N = 330$, $r = -.1355$, $p = .007$). (See Table 6.2.) These results support Witkin's (1977) contention that the constructs of locus of control and cognitive styles are closely related.

A battery of standardized measures was used by the participants to gather information concerning academic and personal attributes. Mean scores were calculated by gender for each measure. These are displayed in Figure 5.3. Generally, the data do not reveal any differences between the sexes. There is, however, a slightly higher mean score on the Spatial Experience Questionnaire in favor of males. Thus, in this sample of minority students, males have had more spatial experiences and have enjoyed such activities more than females. This finding parallels research concerning majority students (Bouchard and McGee, 1977; Petrusic, Varro, and Jamieson, 1978; Vanderberg and Kust, 1978; Guay and McDaniel, 1978).

FIGURE 5.3

Mean Scores of Males and Females on Selected Standardized Measures



Cognitive Style

One of the attributes which has been identified as contributing to achievement differences in science is one's mode of cognitive style. Cognitive style refers to the way in which one perceives one's environment. Recently Cross (1976) and Douglass (1978) have suggested that type of cognitive style also affects how efficiently one learns in a particular learning environment and how effectively one solves problems. These aspects of cognitive style are discussed in Anthony and Sander's contributions in Chapter 4 and are pertinent to a discussion of the combined data as well.

GEFT scores for all participating schools were combined, and mean (5.23) and median (3.88) scores were calculated. These two averages reflect the skewed distribution, illustrated in Figure 5.4, and indicate a relatively field-dependent mode of cognitive style among these students. This sample mean was below the means (10.8-12.3) of other college samples, shown in Table 5.5. For

FIGURE 5.4

Distribution of Scores on the Group Embedded Figures Test

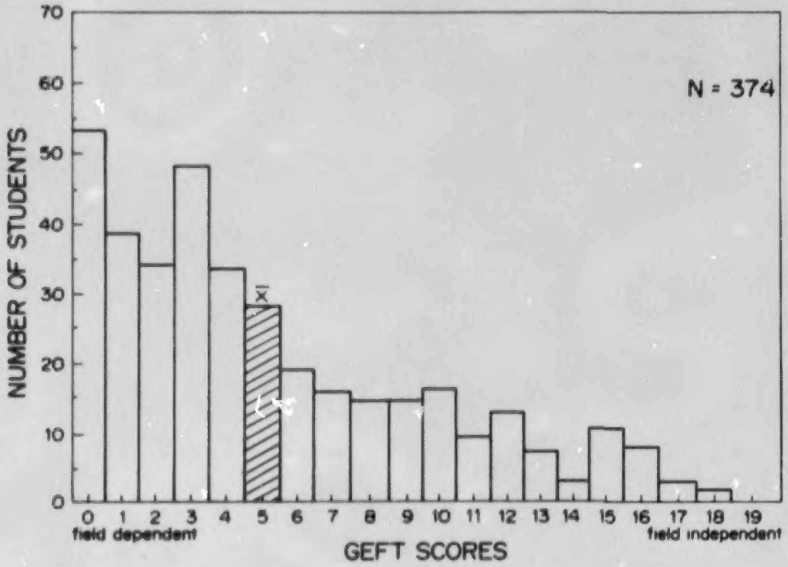


TABLE 5.5

GEFT Mean Scores for Selected Samples of College Students

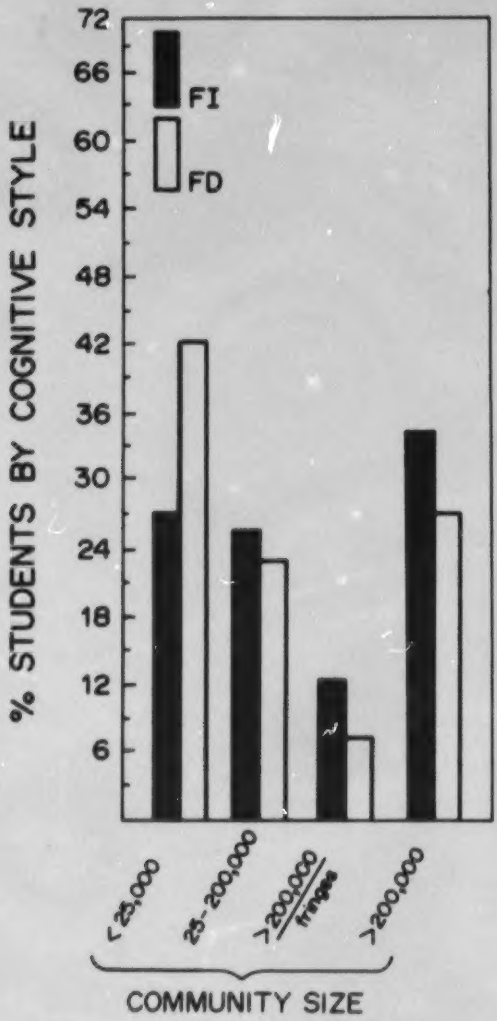
Researcher	Description	N	Sex	Mean
Witkin, 1971	College Students	155	M	12.0
		242	F	10.8
Witkin, Moore,	College Graduates	1256	M & F	11.6
Goodenough, and Cox, 1977	Graduate Students	550	M & F	11.6
Witkin, Moore,	Science Majors	401	M	12.3
Goodenough, and Cox, 1977		173	F	12.1
	"Other" Majors	373	M	11.5
		409	F	11.5
	Education Majors	155	M	12.0
		242	F	10.8
Carter, 1981	Biology Majors	43	M	4.4
	Southern Minority	53	F	3.0
	Colleges	96	Comb.	3.6
Collins, 1981	Biology Majors	45	M	8.9
	Southern Minority	47	F	6.6
	Colleges	92	Comb.	7.4
Kahle, 1981	Southern Minority	193	M	5.3
	College Students	234	F	4.4
		427	Comb.	5.2

further analyses, the sample was divided into field-independent and field-dependent subgroups. In order to obtain a reasonable number in each category, those scoring at or above 12 (N = 44) were placed in a field-independent subgroup, while those scoring at or below 3 (N = 175) were categorized as a field-dependent subsample. These subgroups were compared on several factors. The portion of the sample scoring between 3 and 12 on the GEFT test was not included in these analyses.

Percentages of students grouped as relatively field-dependent or field-independent were compared by community size, by college major, and by mean scores on standardized instruments. Figure 5.5 shows the percentage of field-dependent or field-independent students who live in different sized communities. Generally, the highest percentage of field-dependent students come from the smallest communities and their number decreases proportionately as community size increases. This trend holds until a large urban community is described where the percentage of students classed as field-dependent increases to 25%. Douglass (1981) has identified several reasons for this finding. She states:

FIGURE 5.5

Percentages of Relatively Field-Independent and Relatively Field-Dependent Students by Community Size



KEY: FI = Field-Independent, Scores ≥ 12 (N = 44); FD = Field-Dependent, Scores ≤ 3 (N = 175).

> We would expect inner city students to be relatively field-dependent because, due to their social status, they are forced to juggle more things at one time. . . . This is required of people who have school, job, survival, and child care responsibilities. They do not have the luxury of concentrating on a discrete task independent of the embedding context; that is, of their environment and social circumstances.

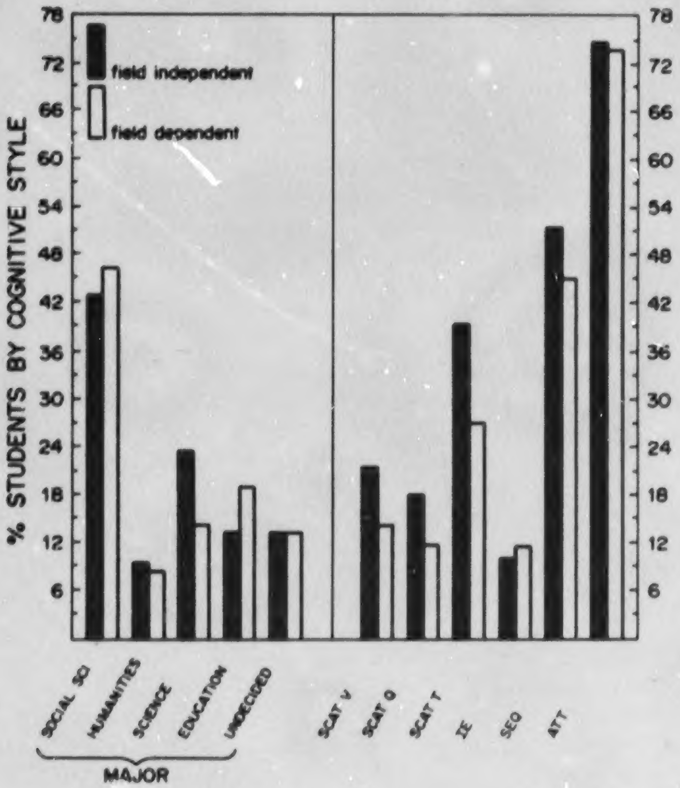
She continues her explanation with the observation that a rural student has several similarities with the inner city student. Often rural students have responsibilities at home (chores) as well as school. Many times the students have responsibilities which are not clearly defined and which, therefore, require a global perspective. Rural students usually must coordinate chores, home responsibilities, and school work. They may not be able to concentrate on a discrete task. In contrast, many suburban/college bound students (fringes > 200,000) work only in the summer, have no child care responsibilities, and often do not have home responsibilities. Therefore, these students are able to focus on school work alone. Thus, they have the luxury of using a field-independent mode in their approach to their environments (Douglass, 1981).

Figure 5.6 presents percentages of relatively field-independent or field-dependent students selecting each college major. Data presented in Figure 5.6 show that a higher percentage of students selecting science as a major are field-independent. Witkin, *et al.*, (1977) found that "students whose preliminary major choices at college entry were compatible with their cognitive style were likely to remain with those majors through college and into graduate school." However, those with incompatible choices tended to shift majors (p. 208). This same study also found some tendency for field-independent students to perform better in mathematics and the natural sciences. Our minority group data agree with the majority of studies with college populations that relatively field-independent students have been found to achieve significantly higher in science as well as in mathematics, architecture, and engineering (Dubois and Cohen, 1970; Hunt and Randhawa, 1973; Rosett, Robbins, and Watson, 1968). Thus, the selection of science as a college major by more field-independent students at minority colleges and universities is similar to and supports previous findings. Evidently all of these data reflect a greater success in science by field-independent students.

The remaining data presented in Figure 5.6 show percentages of relatively field-independent and field-dependent students scoring above the mean on each of the standardized tests used. In all sections of the School and College Aptitude Test, more field-independent students scored above the mean. This finding is consistent with others which show a relationship between a field-independent mode of cognitive style and other measures of school ability and aptitude (Douglass, 1976; Lehman, 1979; Sherris, 1980). However, nearly equal percentages of field-independent or field-dependent students were characterized as internal or external, and equal percentages had positive attitudes toward biol-

FIGURE 5.6

Descriptive Data for Relatively Field-Independent and Relatively Field-Dependent Students



KEY: FI = Field-Independent, Scores ≥ 12 (N = 44); FD = Field-Dependent, Scores ≤ 3 (N = 175).

ogy. More field-independent students scored above the mean on the Spatial Experience Questionnaire, indicating that these students had and enjoyed more spatial experiences.

In summary, when this sample of southern minority students was divided into two groups, relatively field-independent and field-dependent, the following differences were noted:

1. The sample did not form a normal distribution according to scores on the GEFT test of cognitive style.
2. Generally, percentages of field-dependent students decreased with increased size of home community.
3. Twenty-three percent of the students selecting science as a college major had a field-independent mode of cognitive style, whereas only 14% of those characterized as field-dependent indicated science as their major.
4. Higher percentages of students classed as field-independent scored above the group mean on the following measures: SCAT verbal, SCAT quantitative, SCAT total, and SEQ.
5. Approximately equal percentages of field-independent and field-dependent students had positive attitudes toward biology and were identified as internally or externally oriented on a locus of control scale.

Locus of Control Orientation

Another attribute which was analyzed extensively was the personality dimension of locus of control. Many studies have found that blacks and persons from disadvantaged socio-economic situations generally see themselves as more externally controlled than majority individuals and those from higher socio-economic levels (Battle and Rotter, 1963; Lefcourt and Ladwig, 1966). Joe (1971) suggests that these

> . . . data are consistent with the theoretical expectation that individuals who are restricted by environmental barriers and feel subjected to limited material opportunities would develop an externally oriented outlook on life. Also, social class interacts with race so that individuals from the lower classes and minority groups tend to have high expectancies of external control (p. 624).

Both mean and median scores for Rotter's IE scale (9.98 and 10.38 respectively) were obtained. As Figure 5.7 shows, the total sample approximated a normal distribution, but with some emphasis toward the external control side of the distribution. The sample mean was similar to that of other comparable samples, shown in Table 5.6, which ranged from 7.12 to 9.79. Scores more than one standard deviation (± 3.8) above and below the mean were used to separate subjects into two groups, internal and external; those scoring at or above 14 were considered externally oriented, while those scoring at or below 6 were considered internally oriented. Again, the middle group of students was not included in the following comparisons.

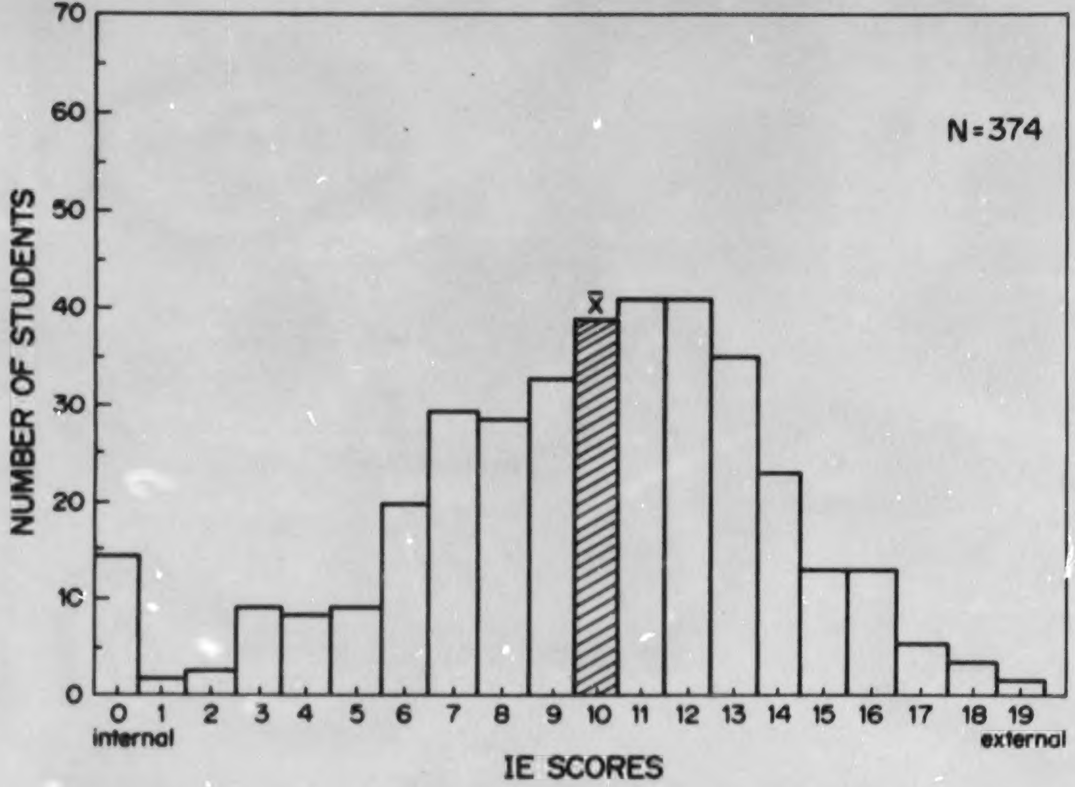
TABLE 5.6

Internal/External Mean Scores for Selected Samples of College Students

Researcher	Description	N	Sex	Mean	SD
Gore and Rotter, 1963	Florida State Univ.	62	M	–	–
	Black students enrolled	54	F	–	–
	Psychology	116	Comb.	9.05	3.66
Ware, 1964	Kansas State Univ.	46	M	7.71	3.84
	Elementary	68	F	7.75	3.79
	Psychology	114	Comb.	7.73	3.82
Crown and Conn, 1965	18-year-olds	32	M	10.00	4.20
	from Boston Area	25	F	9.00	3.90
		57	Comb.	9.56	4.10
Rotter, 1966	Ottis State	575	M	8.15	3.88
	Elementary	605	F	8.42	4.06
	Psychology	1180	Comb.	8.29	3.97
Hsieh, Shybut, and Lotsof, 1969	Anglo American	131	M	–	–
		108	F	8.42	4.06
		239	Comb.	8.58	3.89
	American Chinese	38	M	–	–
		42	F	–	–
		80	Comb.	9.79	3.07
	Chinese (Hong Kong)	241	M	–	–
		102	F	–	–
		343	Comb.	12.07	3.96
Armstrong, 1980	Purdue University	24	M	7.12	3.13
	Biology Majors	33	F	7.57	3.88
		57	Comb.	7.39	3.56
	Elementary Education	3	M	8.67	2.88
	Students Enrolled in	106	F	8.52	4.16
	Introductory Biology	109	Comb.	8.52	4.12
Carter, 1981	Minority College	45	M	9.04	3.50
	Students in Introductory	59	F	9.98	3.52
	Biology Course	104	Comb.	9.58	3.53
Collins, 1981	Minority College	45	M	8.93	4.19
	Students in Introductory	47	F	8.34	4.56
	Biology Course	92	Comb.	8.63	4.37
Kahle, 1981	Minority Students from	165	M	9.78	3.78
	Five Southern Colleges	218	F	10.16	3.83
		383	Comb.	9.97	3.81

FIGURE 5.7

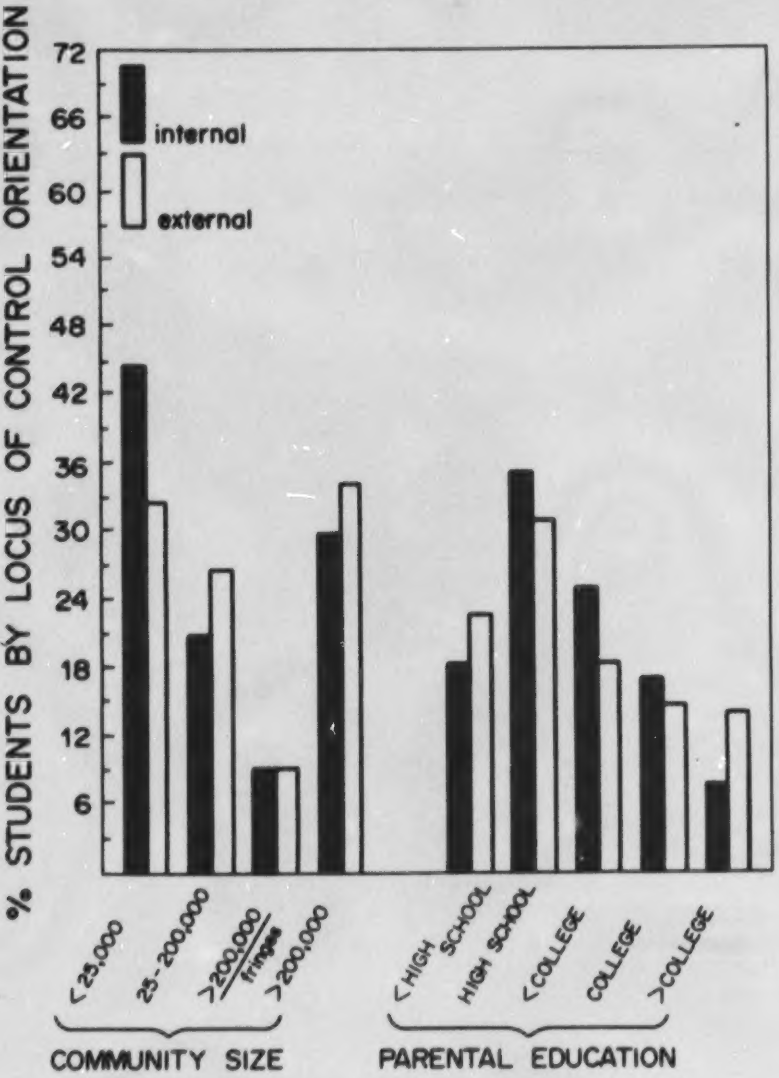
Distribution of Scores on Rotter's I/E Scale



KEY: $\bar{X}$ = 9.90; Mdn. = 10.18

FIGURE 5.8

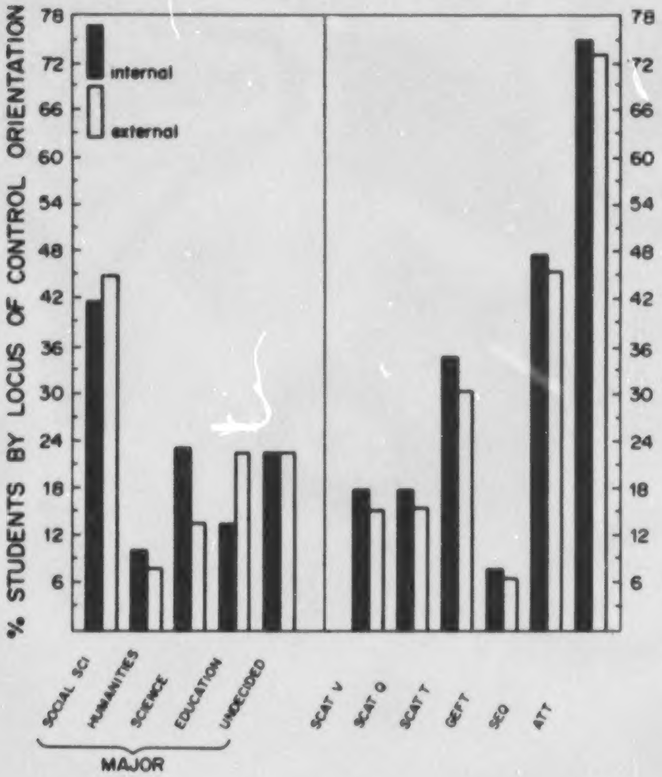
Percentages of Relatively Internal and Relatively External Students by Community Size and Parental Education



KEY: Internal = Scores ≥ 14 (N = 59); External = Scores ≤ 6 (N = 80).

FIGURE 5.9

Descriptive Data for Relatively Internal and Relatively External Students



KEY: Internal = Scores ≥ 14 (N = 59); External = Scores ≤ 6 (N = 80).

Percentages of students grouped as internal and external are shown in Figures 5.8 and 5.9. Figure 5.8 presents the percentages of these subgroups who are either internal or external in their locus of control orientation by community size and level of parental education. A higher percentage of the internally oriented subjects came from small communities (less than 25,000) and from families in which the parents had at least a high school education.

Interestingly, the data presented in Figure 5.9 concerning choice of college major by internally or externally oriented students supports certain precepts of this dimension. For example, more internally oriented individuals select science as a major. Since the scientific process, by definition, explicitly excludes fate, chance, or luck, external students have not selected science as a field of study.

Higher percentages of internally oriented students score above the mean on both the verbal and quantitative portions of the SCAT test. However, the difference in percentages is not as great as those found between field-independent and field-dependent students on these same measures. Only slight differences are noted in percentages of external or internal students scoring above the mean on other measures (cognitive style, spatial experiences, attitudes toward biology).

Again, certain conclusions may be drawn from the data concerning locus of control orientation.

1. The sample was nearly normally distributed according to locus of control orientation.
2. Higher percentages of internally oriented students came from rural home communities and had parents with at least a high school education.
3. Science was selected as a college major by a higher proportion of internally oriented students than externally oriented ones.
4. Approximately equal percentages of both internal and external students score above the mean on selected standardized measures of aptitude.

Summary

Many suppositions were substantiated and others brought into question by the combined data on this sample of minority students. For example, the students were nearly normally distributed along the locus of control continuum. However, a markedly skewed distribution was found in relation to mode of cognitive style. When extreme scores from the total sample were used to select a relatively field-independent subsample and a relatively field-dependent subsample, common characteristics became evident. For example, the field-dependent subsample was described as living in either rural communities or in large urban areas, as preferring social science or education for a college major, and as scoring slightly below the mean on all measures of aptitude and of spatial experience. On the other hand, the subsample of students designated as internally oriented (those who scored one standard deviation or more above the mean on Rotter's I/E scale) were more likely to be from rural communities, to have parents with at least a high school education, and to select science as a college major.

The range of scores obtained on selected standardized measures (Table 5.4) should be noted as well as the general distribution of students according to demographic factors (Tables 5.1, 5.2, and 5.3). Obviously the participating colleges draw from a variety of communities and socio-economic levels, attracting a diverse undergraduate population. The data, collected by survey and by standardized instruments, provide a profile of a previously undescribed population. Insights from these data should help college administrators and faculties to better meet educational needs of southern minority college students.

NOTES

1. This test is described in Chapter 4 in Gwendolyn Davis, "The Efficacy of Spatial Ability and Other Selected Measures in Predicting Mathematics Achievement of Minority Students."
2. Kahle (1979) cites the following National Assessment of Educational Progress data: 82% of black 17-year-olds compared with 58% of white 17-year-olds think that science should be required; 73% of black 17-year-olds compared with 54% of white 17-year-olds think that science education is, in the long run, worth the expense and effort expended.

REFERENCES

Battle, E., and Rotter, J.B. "Children's Feelings of Personal Control as Related to Social and Ethnic Groups." *Journal of Personality* 31 (1963):482-490.

Bouchard, T., and McGee, M.G. "Sex Differences in Human Spatial Ability: Not an X-linked Recessive Gene Effect." *Social Biology* 24 (1977):332-335.

"Cooperative School and College Ability Tests." Menlo Park, California: Educational Testing Service, Addison-Wesley Publishing Company, 1966.

Cross, P. "Beyond Education For All—Toward Education for Each." *The College Board Review* 99 (1976):5-10.

Douglass, C. "Differences in Attitude, Self-Concept, and Analytical Ability of Biology Majors, Non-Majors, and Pre-Service Teachers." Unpublished paper. Mt. Pleasant, Michigan: Central Michigan University, 1978.

Douglass, C. Personal communication, Purdue University, April 1981.

Douglass, C. "The Effect of Instructional Sequence and Cognitive Style on the Achievement of High School Biology Students." Unpublished doctoral dissertation, Purdue University, 1976.

Dubois, T.E., and Cohen, W. "Relationship between Measures of Psychological Differentiation and Intellectual Ability." *Perceptual and Motor Skills* 32 (1970):411–416.

Feather, N.T. "Change in Confidence Following Success or Failure as a Predictor of Subsequent Performance." *Journal of Personality and Social Psychology* 9 (1968):38–46.

Guay, R., and McDaniel, E. "Correlates of Performance on Spatial Aptitude Tests: A Final Report." U.S. Army Research Institute for Behavioral and Social Sciences, Grant No. DAHC 19-77-G-0019. November 1978, pp. 1–171.

Hunt, D., and Radhawa, B.S. "Relationship between and among Cognitive Variables and Achievement in Computational Science." *Educational and Psychological Measurement* 33 (1973):921–928.

Ignatz, M.B. "Low Black Enrollment in Chemistry and Physics Courses." *Science Education* 4 (1975):571–573.

Joe, V.C. "Review of the Internal-External Control Construct as a Personality Variable." *Psychological Reports* 28 (1971):619–640.

Kahle, J.B. "An Analysis of Minority Attitudes toward Science from the 1976-77 National Assessment of Science Results." In *National Assessment of Educational Progress, Attitudes toward Science*. NAEP Science Report No. 08-S-02. Denver: Education Commission of the States, 1979.

Lefcourt, H.M., and Ladwig, G.W. "Alienation in Negro and White Reformatory Inmates." *Journal of Social Psychology* 68 (1966):153–157.

Lehman, J.D. "A Piagetian-based, Audio-tutorial, Instructional Strategy and the Levels of Achievement, Cognitive Development, and Creativity of High School Biology Student." Unpublished doctoral dissertation, Purdue University, 1979.

Maccoby, E.E., and Jacklin, C.N. *The Psychology of Sex Differences*. Stanford, California: Stanford University Press, 1974.

National Assessment of Educational Progress (NAEP). *Three Assessments of Science, 1969-1977: Technical Summary*. Report No. 08-S-21. Denver: Education Commission of the States, 1979.

National Science Foundation (NSF). *Science Education Databook*. SE-80-3. Washington, D.C.: National Science Foundation, 1980.

Oltman, P.K.; Raskin, E.; and Witkin, H.A. *Group Embedded Figures Test Manual*. Palo Alto, California: Consulting Psychologists Press, 1971.

Petrusic, W.M.; Varro, L.; and Jamieson, D.G. "Mental Rotation Validation of Two Spatial Ability Tests." *Psychological Research* 40 (1978):139–148.

Phares, E.J. *Locus of Control in Personality*. Morristown, New Jersey: General Learning Press, 1976.

Rosett, H.L.; Robbins, H.; and Watson, W.S. "Physiognomic Perception as a Cognitive Control Principle." *Perceptual and Motor Skills* 26 (1968):701–719.

Rotter, J.D. "Generalized Expectancies for Internal Versus External Control of Reinforcement." *Psychological Monographs: General and Applied* 80 (1966):1–28.

Sherris, J.D. "The Effects of Instructional Organization and Selected Individual Difference Variables on the Meaningful Learning of High School Biology Students." Unpublished doctoral dissertation, Purdue University, 1980.

Stake, R.E.; Easley, J.; et al. *Case Studies in Science Education* (Volume I: The Case Reports; Volume II: Design, Overview, and General Findings) Washington, D.C.: National Science Foundation, U.S. Government Printing Office, 1978.

Vandenberg, S.G., and Kust, A.R. "Mental Rotations, A Group Test of Three-Dimensional Spatial Visualization." *Perceptual and Motor Skills* 47 (1978):599–604.

Vockell, E.L., and Lobonc, S. "Sex-Role Stereotyping by High School Females in Science." *Journal of Research in Science Teaching* 18 (1981):209–219.

Witkin, H.A.; Moore, C.A.; Goodenough, D.R.; and Cox, P.W. "Field-Dependent and Field-Independent Cognitive Styles and Their Educational Implications." *Review of Educational Research* 47 (1977):1–64.

6 Reflections and Recommendations

If a nation expects to be ignorant and free, in a state of civilization, it expects what never was and never will be. — Thomas Jefferson from a letter to Col. Charles Yancey, January 6, 1816.

Introduction

The small number and relatively low status of women and minority scientists in higher education is an area of national concern. As described in Chapter 1, three barriers have been identified which inhibit participation and advancement by these groups:

1. Limited access to advanced training,
2. Insufficient access to formal and informal networks relating to research and publishing, and
3. Lack of role models. (Baker and Hartley, 1979, p. 3).

The project described in the preceding pages addressed all three barriers. The target population was women in science and science education from the colleges and universities which compose the Alabama Center for Higher Education. The project was designed to assist these women through the total research and dissemination process from experimental design to publication of articles.

Participants

Successful recruitment was largely due to the personal approach used by Cobb. Although there was no attempt to select on any factor except the academic competencies necessary for the rigorous work required, all participants were black and most had common backgrounds, goals, and personalities. Most were from small families, had baccalaureate degrees from minority institutions, held master degrees from majority institutions, and taught in private church-supported institutions. After selection, all participants delineated their goals and completed the Myers-Briggs personality assessment[1] so that the project could be structured appropriately. Interestingly, according to this instrument, all of the participants had similar personality inventory patterns. The Myers-Briggs Type Indicator identifies individuals along four dicotomous scales: extrovert/introvert, sensing/intuitive, thinking/feeling, and judging/perceptive. An individual's type consists of the combination of one preference from each of the four scales (Charlton, 1980). Although the participants varied as to personality type, all placed in the judging category. That is, they all preferred objectives, order, and clear plans. This finding affected the project in two ways. First, the participants' personalities were compatible with the goals of the project; and, second, the individual projects were structured so that each worked toward her goal in a deliberate, organized fashion, assuring the eventual success of her research. The similar personalities also facilitated the completion of the collective project.

Participants benefitted from the opportunities afforded by the project both as individuals and as future leaders in science education. Although only accomplishments completed during the tenure of the project can be tabulated now, they are impressive. Advances have been divided into two categories: those affecting the individual women and those affecting the group in general.

Individual Accomplishments Related to Project Goals

1. Seven of the original 10 participants returned for the second summer.
2. Six of the seven completed articles about their research.
3. All submitted their papers to an appropriate journal.
4. Two of the seven served on review panels for the National Science Foundation.
5. Five of the seven returned to universities for advanced degrees or post doctoral work.
6. Two of the seven conducted workshops concerning women in academia on their home campuses.
7. Two of the seven presented follow-up papers at a major regional meeting, partially at their own expense.
8. One was appointed to a national committee on the status and role of women in biology education.

Group Advances Related to Project Goals

1. Extensive liasons formed between the participants and the over 20 women who were either paid or volunteer consultants during the period of the grant.

2. A close, cooperative peer network developed between the participants, which continues to provide immediate aid and mutual support even while working on their individual campuses.
3. A supportive professional network of women in science education developed and is operating at three levels: among advanced professional women; between advanced professional women and entering professional women; and among entering professional women.
4. An informal pattern of mentors was promulgated and is evident at national and regional conventions, in the job market, and through informal exchanges of ideas and expertise.

The above are professional accomplishments; it is beyond the scope of these pages to describe the personal friendships and liasons which developed. Taken together—both personal and professional—a new working, supportive cadre of women in science and science education now exists.

Participating Institutions

Differences and similarities among the five cooperating southern institutions have been noted in previous chapters. Three of them, Miles, Stillman, and Talladega Colleges, are in the tradition of the historical black college—small, private, and historically church-supported. The other two reflect different influences in southern, minority, higher education. Alabama A&M University is a land grant institution, whose founding was instigated by the Morrill Act in 1890. It has served southern black students by offering technical and agricultural education. Modern changes mandated the founding of Atlanta Junior College. As the demand for higher education for minorities increased in the 1960s, southern college and university systems were strained to accept additional students. Atlanta Junior College, part of the University of Georgia System, was established to provide convenient access to college education for all residents of Atlanta. Regardless of these historical differences, all five institutions have primarily black students. They constitute, therefore, a major future resource of potential minority scientists, engineers, and technicians. This potential has not been fully realized, although specific programs have been instigated and are continuing to be developed through consortia efforts.

Similarities and Differences

Because individual participants and institutions chose whether to administer the demographic survey, data from all institutions is not available. However, the responses are representative of the three basic types of institutions in the project. The data, displayed in Tables 5.1, 5.2, 5.3, were collected at Miles and Talladega Colleges (black, liberal arts), at Alabama A&M University (black, land-grant), and at Atlanta Junior College (black, urban).[2] The data indicate differences among these three kinds of institutions. For example, students attending institutions in urban areas (Miles and Atlanta Junior colleges) more often hold outside jobs and work longer hours than those attending the other schools. According to Table 5.1, over 60% of the students attending Miles and Atlanta Junior College work more than 10 hours per week at an outside job. No student surveyed at Talladega or at Alabama A&M reported working over 10 hours/week at an outside job. Whether this difference is due to administration of the questionnaire, age of student, socio-economic status of student and his/her family, availability of jobs, or location of institution was not ascertained. However, Atlanta Junior College students reported the greatest number of work hours and were generally older than students at other colleges surveyed.

Student work patterns in the urban institutions surveyed indicate a need for flexible schedules and curricula. Participants from both Atlanta Junior and Miles colleges expressed concerns with their institutional schedules. Specifically if potential black scientists are to be trained at these institutions, flexible schedules, alternating laboratory and lecture sessions in the evenings, are mandated. This type of scheduling may require longer than the traditional quarter or semester for course completion, and this adjustment must be made also. In addition, self-paced instruction such as the audio-tutorial programs discussed in Chapter 4 at Talladega, Miles, and Atlanta Junior colleges may be essential to meeting the needs of such students, although they may not be as cost effective as traditional formats.

Another difference, noted in Table 5.2, which may be attributed to an urban setting is the number of periodicals available in homes. Students attending urban colleges reported more access to these materials. Two differences, number of work hours per week and number of outside reading materials, may be attributed, then, to urban location, not to type of institution.

Another difference among these institutions was noted in the ratio of female to male students. The data, displayed in Table 5.1, were collected in biology and mathematics classes, yet more women than men students were recorded at Atlanta Junior College and at Talladega College, while approximately equal numbers of males and females were recorded at Miles College and Alabama A&M University. The number of women attending urban colleges part-time is probably the cause of this difference at Atlanta Junior College. When the participants were queried about the disproportionate number of women reported at Talladega College, they responded that enrollment data show more female than male students at historically liberal arts colleges for blacks. This fact is masked in the data collected at Miles and Stillman colleges because biology classes, which enroll more males, were studied. They suggested the traditional pattern in southern black families has been to send daughters to college. Even today, families are more likely for social reasons to enroll daughters than sons in small, church-related, black colleges.

The size of home communities of the total sample (Figure 5.3) reflects the location of the respective institutions, except in the case of Miles College. Although Miles College is within the greater metropolitan area of Birmingham, Alabama, over 30% of its students come from rural communities. Participants from Miles College attribute this finding to its historical and religious traditions as well as to its open admission policy. Traditionally Miles College has provided higher educational opportunities for students throughout Alabama. In the future, perhaps the various programs such as the Community Outreach Program, sponsored by ACHE, will increase the number of minority rural students attending all types of southern colleges and universities.

Although there are similarities among these southern minority institutions, there are interesting differences. Some differences (reading materials, working hours) are attributable to the location of the school; others (gender ratio, home communities) are related to type of institution. Some of these differences, however, may require different staffing and scheduling patterns on individual campuses.

TABLE 6.1

Full-Time Black Enrollment as Percentage of Total Enrollment by Type and Control of Institution, 1976 and 1978

Type and Control Institution		Year	
		1976	1978
Public Universities	N	75,996	102,162
	%	4.8	9.7
Private Universities	N	31,403	44,825
	%	6.5	4.3
Other 4-Year Public	N	223,208	322,718
	%	11.9	30.6
Other 4-Year Private	N	107,116	142,050
	%	9.4	13.5
2-Year Public	N	205,395	414,640
	%	13.1	39.3
2-Year Private	N	16,479	27,972
	%	13.9	2.7

SOURCE: *The Condition of Education*, 1978, p. 118; *The Condition of Education*, 1980, p. 110.

Continued Growth and Development

Throughout this work, concern has been expressed about the education of minority students. In addition, the future of historically black institutions of higher education has been addressed. Indeed, national data such as that presented in Table 6.1 gives rise to these concerns. This table presents the enrollment of blacks as a percentage of total enrollment at six different types of institutions of higher education. For example, blacks account for over 39% of the total enrollment in public, two-year colleges. On the other hand, blacks comprise only 13% of the total undergraduate enrollment at private four-year colleges. Although the percentage of blacks in the total enrollment of private colleges increased by 4% between 1976 and 1978, there is no clear indication that the increase was at traditional black colleges. During that same period, black enrollment as a percentage of the total enrollment at other types of institutions increased dramatically. For example, black students as a percentage of total enrollment increased 26% at public two-year colleges; 19% at public four-year colleges; and 15% at public universities. All of these enrollment trends raise concerns over the future of traditional black, private, liberal arts colleges such as Miles, Talladega, and Stillman. If these enrollment trends continue into the 1980s, both Alabama A&M University and Atlanta Junior College will thrive. However, public two-year institutions are relatively new and outside of the traditional educational route of black students. Their success in fostering the development of minority scientists, doctors, dentists, and engineers has not been assessed.

Varied solutions have been offered recently concerning increased minority participation in higher education; two are pertinent to our discussion. Kenneth Clark (1979) has developed the thesis that historically black colleges should "become academies with educational objectives of seeking to compensate for the previous 12 years of educational inferiority and prepare their students for a single standard high level of collegiate, graduate, and professional education" (p. 64). He maintains that the task requires a fundamental "rethinking of the traditional structure, organization, objectives, and goals of higher education of American blacks which were inherited as part of a legacy of American racism" (p. 64). This rethinking will necessitate redefining the traditional four-year program for a baccalaureate degree and altering course offerings at many minority institutions. As he says, we must ". . . define a college degree not in terms of the appearance of academic courses, not in terms of a stated amount of time, but in terms of actual academic achievement. Each student must be provided with the time he or she needs to reach a level of academic performance which would make him or her able to compete with others on a single standard of academic competition" (p. 64).

Clark's proposal is directed at colleges such as Miles, Stillman, and Talladega. When his article was discussed with women faculty from these institutions, they unilaterally rejected his suggestions. They considered his approach both objectionable and racist. Each expressed concern about the "brain drain" from their campuses to prestigious northern colleges and universities. In fact, some maintained that their ablest students were lured away with financial packages. In addition, they worried about the rising cost of education at historically black colleges so that these institutions were no longer competitive with public southern institutions, now accessible to black students. They hoped, however, that increasing numbers of bright black students would elect to attend historically black colleges. They clearly perceived the role of these colleges to educate black leaders and professionals, and, as faculty members, they focused on continuing that historical mission. They were not interested in, indeed, they were insulted by, the suggestion that their colleges become interim "academies."

If Clark's direction is to be fruitful, the faculties and administrators of these institutions will have to radically change their stance. Obviously the Alabama Consortium of Higher Education has sought another answer. It has provided a way for southern minority colleges to pool their strengths and resources in order to upgrade their curricular offerings.

A second suggestion is directed toward providing higher education for more black students. However, it may not strengthen the historically black colleges and universities; indeed, it may have the opposite effect. Lewis (1979) documents the need for non-traditional community colleges established specifically to deal with the students' educational deficiencies. For example, he maintains that two-year, nontraditional colleges could provide opportunities ". . . for students who did not complete high school subjects which are required for four year college admissions, to be able to take such subjects; for students who lack skills necessary for success in four-year college subjects, to be able to improve such skills; and for students whose high school grade point average is not high enough for admission to a four-year college, to be able to improve their scholastic records" (1979, p. 40). Both Clark and Lewis are suggesting the same basic solution to the problem of increased minority participation in higher education; that is, the improvement of the students' basic skills and academic backgrounds.

However, they are suggesting alternative ways of reaching that goal. Lewis (1979) suggests that this goal is beyond the mission of the historically black colleges. He sees their contribution as providing black leaders who will contribute to a "democratic pluralistic society, through [their] transformation of the black community from a disadvantaged, poverty-crippled segment of American society into a liberated ethnic group" (p. 40). He recommends that the historically black colleges establish new missions as well as high standards for selecting and evaluating students. The minority two-year community college, on the other hand, will focus on the special needs of nontraditional students. The faculty participating in this project concurred with Lewis' evaluation of the role of traditional black colleges.

Both directions should lead to increased opportunities in higher education tailored to the needs of more black students. The complexity of the problem, as well as the strong tradition of southern minority colleges and universities, suggests that both directions must be taken.

Participating Students

This project concerned upgrading the research skills of women faculty at minority institutions. However, each of these women was primarily concerned with another issue; that is, with improving learning in her classroom. Their research projects were not academic exercises in statistical analyses or in controlling internal and external experimental errors, they were realistic appraisals of their students—of the personal, social, and academic factors affecting achievement in their classes. In the long run, the success of the project lay not so much in the number and expertise of the consultants nor in the sophisticated research skills learned, as in the strides made by the participants in understanding how to help their students learn. Their intense research effects were directed toward that goal.

The combined data collected by the participants displayed several significant correlations. These correlations, based on data in Table 6.2, are as follows:

1. Locus of control and cognitive style: individuals with an internally oriented locus of control ("internals") had a more field-independent mode of cognitive style.

TABLE 6.2

Pearson Product Moment Correlations between Selected Variables

	IE	GEFT	SCATV	SCATQ	SCATT
IE			NS	−.15 (105) p = .059	−.18 (105) p = .033
GEFT	−.14 (330) p = .007		.52 (119) p = .001	.33 (119) p = .001	.52 (118) p = .001
SEQ	−.14 (268) p = .012	.20 (236) p = .001	NS	NS	NS

KEY: ( ) = N; NS = Non-Significant.

2. Locus of control and number and enjoyment of spatial experiences: "internals" had more spatial experiences and enjoyed them more than external individuals.
3. Cognitive style and number and enjoyment of spatial experiences: field-independent students had more spatial experiences and enjoyed them more than field-dependent individuals.
4. Standardized measures of verbal and quantitative ability (SCAT V, SCAT Q, and SCATTOT) with locus of control and with cognitive style: Internal individuals had higher scores on the SCAT quantitative, while field-independent individuals scored higher on both the verbal and quantitative portions. High SCAT total scores correlated significantly with both internal locus of control orientation and field-independent cognitive style.

Although the first three itemized correlations were expected, several results were not. For example, the sample was not expected to approximate a normal distribution in regard to locus of control (Figure 5.7). Many studies have reported that minority studentsare oriented more toward the external end of that continuum. However, Escoffery reported that in three predominantly black colleges, Virginia State College, North Carolina Agricultural and Technical College, and Morgan State College, the sense of locus of control of male undergraduates was determined more by contemporary social forces than by personality type (Escoffery in Weinberg, 1977, p. 146). Our data indicate that more students rank in the external than the internal half of the locus of control scale.

The locus of control orientation of minority students is important in two ways. First, science precludes a belief in "luck," "fate," or "powerful others"; therefore, potential minority scientists must be internally oriented in terms of control. Second, the correlations between internal control and standard measures of academic aptitude suggest that improved achievement may be obtained by helping students become more internally oriented.

Research concerning locus of control orientation has focused on understanding and interpreting this personality dimension, not on changing or redirecting individual orientations. However, Rowe's (1978) pioneering work indicated directions that are successful with younger students. Some of these techniques may be extrapolated to older students. For example, science instruction must provide sufficient time to work with experimental materials so that events may be repeated. Such experiences will introduce the notion that events are replicable and, therefore, under one's own control. She suggests that the opportunity to work directly with science materials is especially important for external individuals. She states, "This may be the most specific kind of intervention available to help them develop a sense that the world can to some extent be managed by them. . . . There may be a connection between developed ability to understand and manage science phenomena and problem solving in social, economic, and political contexts" (p. 393). It is important that minority students with external orientations be enrolled in laboratory, science experiences.

The extremely skewed distributions of the sample in relation to cognitive style was not expected (Figure 5.4). However, this result is important. It indicates, for example, the need for both curricular and instructional changes. In teaching primarily field-dependent students at southern minority colleges, instructors should use deductively sequenced curricular materials (Douglass, 1979) and teach in a manner which maximizes learning by field-dependent students. For example, discussion sessions, directed problem-solving experiences, and controlled experiments in structured laboratories may be more pertinent activities than discovery or open-ended laboratories. In addition, Cross (1976) has suggested that these instructional strategies may increase a student's ability to separate an object from its embedding field; i.e., to become more field independent. Although it is not suggested that a field-independent mode is preferable to a field-dependent one, academic success, particularly in science, mathematics, and engineering, is related to a field-independent cognitive style.

Because of the sensitivity surrounding the use of standardized measures of ability and aptitude with minority students, the participants were particularly interested in the correlations between the GEFT test and the subscores and total scores of the School and College Aptitude Test. These results suggest the short, non-verbal, easy-to-grade Group Embedded Figures Test may be used as a preliminary screening tool for minority students. Its results could be used with other information about the students to place students in remedial sections, to suggest teaching strategies appropriate for the majority of students, and to counsel students into appropriate majors.

A profile of specific characteristics of a sample of southern minority students has been presented; now recommendations to increase their participation in science are needed. As a 1980 report to the President of the United States states:

> Whatever the causes, the minority underrepresentation in science-oriented pursuits begins early in the educational process. Blacks and Hispanics enter college at lower rates that Whites. . . .
>
> Once started in college, both Black and Hispanic students withdraw at slightly higher rates than do White students at four-year institutions. Under all circumstances, the withdrawals are heavily (73 percent-88 percent) for non-academic reasons, which suggests that economics play a significant role. (NSF/DOE, 1980, p. 62-63)

The need for additional financial aid has been discussed in Chapter 3. The consortium of colleges and universities participating in this project has focused efforts to raise monies. However, more is needed.

Another recommendation to increase the participation of minorities in science is based upon data from the National Assessment of Educational Progress (1978) as well as from many independent studies. Considerable evidence shows that positive attitudes are developed in the secondary schools by successful participation in science courses and continual exposure to appropriate role models. Any increase in the number of black scientists, then, must be based on changes in early secondary education such as definitive counseling of minority students into science and mathematics classes.

Summary

The intent of this project was to enhance the research skills and productivity of women faculty at minority institutions. In the course of reaching that goal, other priorities were identified and examined. For example, the participants' overriding concern with their institutions and their students led to analyses of factors affecting each of them. Although it is beyond the scope of this book to analyze the myriad of factors affecting minority higher education, it is hoped that the analyses and discussion within these pages will help focus resources and efforts to eliminate barriers to the full participation of minority students and to foster progress of minority institutions and their faculties.

The results of the project suggest specific ways to alleviate barriers to women in academe. Specifically, for women in science and science education with primarily teaching positions, a change in research direction is recommended. Problems can be identified, experiments can be designed, and analyses can be run which require no materials beyond the curricula, no subjects beyond the students, and no apparatus beyond the classroom or teaching laboratory. Research into factors affecting the achievement of students can lead to personal as well as professional growth and advancement.

This project, which has helped participants develop research and writing skills over a period of three years, has met its goal: the increased research productivity of women faculty at minority institutions. As a result, minority women, who have been described as the forgotten members of academe, have become active and productive on a national level.

During the course of the project, two broader goals were identified: increased participation of minority students in science courses and careers and continued growth and development of southern minority institutions of higher education. The success of these participants, in conjunction with others, in reaching these two goals will be analyzed in future assessments, reports to the President, and research compendia. Progress has begun; let us hope that it continues.

NOTES

1. The Myers-Briggs Type Indicator was analyzed by Linda DeTure (Appendix B). All inquires concerning its use and interpretation should be directed to her.
2. In order to assure privacy, the institutions are not specifically identified in any figure or table.

REFERENCES

Baker, G. and Hartley, J. "NIE Program Enhances Chances for Minorities and Women." *Comment* 11 (1979):3.

Charlton, R.E. "Cognitive Style Considerations for the Improvement of Biology Education." *American Biology Teacher* 42 (1980):224-248.

Clark, K.B. "The Continuing Struggle to Desegregate U.S. Education." *Chronicle of Higher Education* 19, 1 (1979):64.

Cross, P. "Beyond Education for All—Toward Education for Each." *The College Board Review* 99 (1976):5-10.

Douglass, C.B. "Making Biology Easy to Understand." *American Biology Teacher* 41 (1979):277-281, 298.

Drake, St.C. "The Black University in the American Social Order." *Daedalus: The Future of the Black College.* Cambridge, Massachusetts: American Academy of Arts and Sciences, 100, 1971.

Kahle, J.B. "Beyond the Status Quo—Women and Minorities in Science." Paper presented at the National Science Supervisors Association, Midwest Science Education Leadership Conference, Gull Lake, Michigan, May 6-9, 1981.

Lewis, R.M. "The Selection, Retention, and Later Success of Black Students at a Non-Traditional Community College." Unpublished doctoral dissertation, Stanford University, 1979.

MacNeil, R.D. "The Relationship of Cognitive Style and Instructional Style to the Learning Performance of Undergraduate Students." *The Journal of Educational Research* 73, 5 (1980):354-360.

Myers, I.B. *Manual: The Myers-Briggs Type Indicator.* Palo Alto, California: Consulting Psychologists Press, 1962.

National Assessment of Educational Progress (NAEP). *Attitudes Toward Science.* Report No. 08-S-2. Denver: Education Commission of the States, October 1979.

National Center for Education Statistics. *The Condition of Education.* NCES-78-405. Washington, D.C.: U.S. Department of Education, 1978.

National Center for Education Statistics. *The Condition of Education.* NCES-80-400. Washington, D.C.: U.S. Department of Education, 1980.

National Institute of Education (NIE). *Reflections and Recommendations: Fourth Annual Report of the National Council on Educational Research.* Washington, D.C.: U.S. Government Printing Office, 1978.

National Science Foundation and Department of Education (NSF/DOE). *Science and Engineering: Education for the 1980's and Beyond.* NSF-80-78. Washington, D.C.: National Science Foundation, 1980.

Rowe, Mary Budd. *Teaching Science as Continuous-Inquiry: A Basic.* New York: McGraw-Hill, 1978.

School Enrollment – Social and Economic Characteristics of Students: October 1977. Series D-20, No. 333. Washington, D.C.: Bureau of the Census, U.S. Department of Commerce, February 1979.

Shymansky, J.A., and Yore, L.D. "A Study of Teaching Strategies, Student Cognitive Development, and Cognitive Style as They Relate to Student Achievement in Science." *Journal of Research in Science Teaching* 17, 5 (1980):369–393.

Weinberg, M. *Minority Students: A Research Appraisal.* Washington, D.C.: National Institute of Education, U.S. Department of Health, Education, and Welfare, 1977.

Appendices

Appendix A

Biographies of Participants

Nell Rice Anthony

Before assuming her current duties as professor of elementary education and chairperson for the Department of Elementary Education at Alabama A&M University in 1971, Nell Rice Anthony held appointments as an associate director of a fellowship program, a Trainer of Teacher Trainers Fellow in Curriculum and Teaching at Columbia University, an elementary methods teacher, and a demonstration teacher and consultant for in-service education. She has directed student teachers for approximately 10 years.

Dr. Anthony received her Ed.D. degree from Teachers College of Columbia University in 1971. She has co-authored an article entitled "Multicultural Education: A New Goal for Teacher Educators," published by Kappa Delta Pi Record in December 1980. She was the recipient of the Outstanding Educator of America Award, 1974-1975. She also received the Certificate of Recognition from the Alabama Reading Association, 1977, and the Certificate of Participation from the Follow Through Workshop, 1978. Dr. Anthony is a member of Kappa Delta Pi Honorary Society, the Association for Curriculum and Supervision, National Education Association, and the Alabama Education Association.

Charlotte Carter

Charlotte Carter received her M.S. degree from University of Tennessee in 1970. She served as an instructor of biology at Miles College in Birmingham, Alabama, from 1970 to 1980. She was named an Outstanding Educator of America in 1973 and 1975. While an instructor at Miles College, she was active in organizations such as the American Association of University Professors and the National Science Teachers Association. She also served as advisor to the Alpha Sigma Chapter of Alpha Kappa Mu National Honor Society.

Ms. Carter currently serves as a teaching assistant at Purdue University and as a university supervisor for undergraduate biology student teachers. She is enrolled in courses leading to a doctoral degree in science education. Her dissertation, supported by the National Science Foundation, will concern factors affecting conceptual learning in science in early adolescent black students.

Mildred A. Collins

Mildred Collins, assistant professor of biology at Stillman College, Tuscaloosa, Alabama, has taught in its undergraduate biology program since 1967. Prior to that time, she was a biology instructor at Rust College and in the Grenada City School System, Grenada, Mississippi.

Since receiving her M.S. degree from Tennessee A&I State University in 1966, Ms. Collins has been an active participant in several symposia. She also received the Educator of the Year Award in 1974, and is a member of the American Institute of Biological Sciences, the National Science Teachers Association, and the American Association of University Professors.

Gwen Wilson Davis

Gwen Wilson Davis has been an instructor in the Department of Mathematics at Talladega College, Talladega, Alabama, since 1978. She received her M.A. degree from State University of New York at Buffalo in 1974. Prior to her employment at Talladega College, she served as a mathematics instructor at Lawson State Junior College, Birmingham, Alabama, and Daniel Payne College, Birmingham, Alabama.

Ms. Davis is an active member of the Alabama Association of College Teachers of Mathematics and the National Council of Teachers of Mathematics. She is also a member of Beta Kappa Chi Scientific Honorary Society.

Barbara Small Morgan

Barbara Small Morgan received her M.S. degree from Atlanta University in 1974, and since that time has taken additional courses at Georgia State University. She has served as an assistant professor of biology in the Department of Natural Science and Mathematics at Atlanta Junior College for seven years.

Ms. Morgan is an active member of the American Association of University Professors, the Association of Southeast Biologists, the National Science Teachers Association, the Georgia Academy of Science, and the International Congress for Individualized Instruction. She has received two academic scholarships.

Olivia H. Sanders

Olivia H. Sanders is an assistant professor of education in the Department of Secondary Education at Alabama A&M University. Her experiences include four years of college-level teaching, five years as an instructional supervisor for Madison County, Alabama, and five years as a junior-high and high school teacher.

Ms. Sanders received her Ed.D. degree from University of Alabama, Tuscaloosa, in 1977. She is a member of the National Education Association and the Alabama Education Association. She is active in Phi Delta Kappa, a professional education fraternity, and Kappa Delta Pi, an honorary society in education.

Sandra Taylor

Sandra Taylor received her M.A. degree from Atlanta University in 1978. She served as an instructor of sociology at Talladega College, Talladega, Alabama, during the 1978-79 school year. She is currently a research assistant in the Department of Sociology at Washington University, St. Louis, Missouri, where she is pursuing her Ph.D. degree in sociology.

Ms. Taylor has been active in the following organizations: Alpha Mu Gamma Foreign Language National Honor Society, Alpha Kappa Delta Sociological National Honor Society, and Alpha Kappa Mu National Honor Society. She has been the recipient of two academic scholarships.

Appendix B

Consultants and Staff

Project Staff

Dr. Jane Butler Kahle, Director
Departments of Education and Biological Sciences
Purdue Universtiy
West Lafayette, Indiana 47907

Dr. Bernice Coar Cobb, Associate Director
Department of Biology
Miles College
Birmingham, Alabama 35208

Ms. Maria Doolittle, Project Coordinator
Department of Biological Sciences
Purdue University
West Lafayette, Indiana 47907

Ms. Sharon Artis, Project Officer
NIE-Minorities and Women's Program
1200 19th Street N.W.
Washington, D.C. 20202

Dr. Gwen Baker, Director
NIE-Minorities and Women's Program
1200 19th Street N.W.
Wahington, D.C. 20202

Project Participants

Dr. Nell Rice Anthony
P.O. Box 231, Department of Education
Alabama A&M University
Normal, Alabama 35762

Ms. Charlotte Carter
Departments of Education and Biological Sciences
Purdue University
West Lafayette, Indiana 47907

Ms. Mildred Collins
Box 4848, Department of Biology
Stillman College
Tuscaloosa, Alabama 35401

Ms. Gwendolyn Wilson Davis
Mathematics Department
Talladega College
Talladega, Alabama 35160

Ms. Barbara Small Morgan
Departments of Natural Science and Mathematics
Atlanta Junior College
Atlanta, Georgia 30310

Dr. Olivia H. Sanders
Department of Education
Alabama A&M University
Normal, Alabama 35762

Ms. Sandra E. Taylor
Department of Sociology
Washington University
St. Louis, Missouri 63130

Project Consultants

Dr. William Asher
Department of Education
Purdue University
West Lafayette, Indiana 47907

Dr. Charlotte Boener
Science Teaching Center
College of Arts and Sciences
Indiana State University
Terre Haute, Indiana 47807

Dr. Joan Creager, Editor
The American Biology Teacher
11250 Roger Bacon Drive
Reston, Virginia 22090

Dr. Kay Deaux
Department of Psychology
Purdue University
West Lafayette, Indiana 47907

Dr. Linda DeTure
1049 Tuscony Avenue
Winter Park, Florida 32789

Dr. Claudia Douglass
Department of Biology
Central Michigan University
Mount Pleasant, Michigan 48859

Dr. Dorothy Gabel
School of Education
Indiana University
Bloomington, Indiana 47407

Dr. Geneva Gay
Department of Education
Purdue University
West Lafayette, Indiana 47907

Dr. Betty Hoskins, Science Editor
Ginn and Company
191 Spring Street
Lexington, Massachusetts 02173

Dr. Classie Hoyle
Affirmative Action, 105 Jessup Hall
University of Iowa
Iowa City, Iowa 52242

Ms. Irene Johnson
School of Science Administration
Purdue University
West Lafayette, Indiana 47907

Dr. Kathryn Linden
Department of Education
Purdue University
West Lafayette, Indiana 47907

Dr. Debbie McDowell
Department of English
Purdue University
West Lafayette, Indiana 47907

Dr. Barbara Moore
Department of Education
Purdue University
West Lafayette, Indiana 47907

Dr. Joseph D. Novak
Department of Education
Cornell University
Ithaca, New York 14850

Dr. Carolyn Perrucci
Assistant Equal Opportunity Officer/Faculty
Purdue University
West Lafayette, Indiana 47907

Dr. Linda Putnam
Department of Communications
Purdue University
West Lafayette, Indiana 47907

Dr. Exyie Ryder
College of Education
Southern University
Baton Rouge, Louisiana 70813

Dr. Susan P. Speece
Department of Education
Anderson College
Anderson, Indiana 46011

Dr. Grayson Wheatley
Departments of Education and Mathematics
Purdue University
West Lafayette, Indiana 47907

Ms. Juanita Williams
Assistant Dean of Students
Purdue University
West Lafayette, Indiana 47907

Dr. Luther Williams
Assistant Provost
Purdue University
West Lafayette, Indiana 47907

Research Associates and Assistants

Dr. Jacqueline Sherris, Research Associate
Departments of Education and Biological Sciences
Purdue University
West Lafayette, Indiana 47907

Ms. Charlotte Carter, Research Assistant
Departments of Education and Biological Sciences
Purdue University
West Lafayette, Indiana 47907

Ms. Barbara Morris, Research Assistant
Department of Education
Purdue University
West Lafayette, Indiana 47907

Ms. Carla Shears, Research Assistant
Department of Education
Purdue University
West Lafayette, Indiana 47907

Ms. Katherine Vandewalle, Undergraduate Research Trainee
Department of Mathematics
Purdue University
West Lafayette, Indiana 47907

Appendix C

Demographic Survey

Please provide the following information about yourself, your school, and your community. All answers will be strictly anonymous and confidential. Please darken the appropriate space on an answer sheet to indicate your selection (from A through E) for each item.

1. Age in years
   a. 16-21
   b. 22-25
   c. 26-35
   d. 36-45
   e. over 45

2. Sex
   a. Female
   b. Male

3. Race
   a. African
   b. Black
   c. Caucasian
   d. Hispanic
   e. Other

4. College which you attend
   a. Alabama A&M University
   b. Atlanta Junior College
   c. Miles College
   d. Stillman College
   e. Talladega College

5. Researcher (please darken only one as appropriate for either 5 or 6)
   a. Dr. Anthony
   b. Ms. Carter
   c. Dr. Clarke
   d. Dr. Cobb
   e. Ms. Collins

6. Researcher (please darken only one as appropriate for either 5 or 6).
    a. Ms. Morgan
    b. Ms. Parsons
    c. Ms. Sanders
    d. Ms. Taylor
    e. Ms. Wilson

7. Size of home community in which you grew up
    a. Smaller places (population less than 25,000 and not classified in the fringes-around-big cities category)
    b. Medium city (cities of 25,000–200,000 not classified in the fringes-around-big-cities category)
    c. Fringes around big cities (outside of the city limits of cities over 200,000)
    d. Big city (over 200,000)

8. Type of community in which you grew up
    a. Rural (communities under 10,000 where most of the residents are farmers)
    b. Small cities (10,000–50,000 mixed communities with one or two high schools)
    c. Disadvantaged urban communities (in *or* around cities of over 200,000 where a high number of residents are on welfare or are unemployed)
    d. Advantaged urban community (in *or* around cities of over 200,000 where a high number of residents are in managerial or professional positions)

9. Level of parental education
    a. Parents did not graduate from high school
    b. At least one parent graduated from high school, but did not continue beyond high school
    c. At least one parent has post high school education
    d. At least one parent graduated from college
    e. At least one parent has an advanced degree (beyond college graduation)

10. Size of family in which you grew up
    a. Only child
    b. Only one brother or sister
    c. Two brothers or sisters
    d. Three or four brothers or sisters
    e. Five or more brothers or sisters

11. Family work pattern
    a. Two-parent family; one parent works outside of the home
    b. Two-parent family; both parents work outside of the home
    c. One-parent family; one parent works outside of the home
    d. One-parent family; no one works outside of the home (external support)

12. Your marital status
    a. Married
    b. Single

13. Your own number of dependent children
    a. None
    b. One or two
    c. Three or four
    d. Four or more

14. Type of family in which you grew up
    a. One or two parents in home
    b. One parent and other adult relatives in home
    c. Two parents and other adult relatives in home
    d. Adult relatives (aunts, uncles, grandparent, etc.) only in home

15. Reading materials available in the home in which you grew up
    a. No magazines or newspapers taken in home
    b. Newspaper regularly taken and read in home
    c. 1-5 magazines and newspapers regularly taken and read in home
    d. 5-10 magazines and newspapers regularly taken and read in home
    e. Cannot remember

16. Size of high school graduating class
    a. Under 25
    b. Between 25-50
    c. Between 50-150
    d. Between 150-500
    e. Over 500

17. Previous science experiences, indicate the greatest number
    a. None
    b. One or more science classes in high school
    c. One or more science classes in college
    d. One or more science classes in high school and in college

18. Previous college experience
    a. None
    b. Trades, technical or vocational school (post-high school)
    c. Attended one college other than the one in which you are enrolled presently
    d. Attended more than one other college

19. Number of hours you are enrolled in classes this semester
    a. Four or less
    b. Five to eight
    c. Nine to eleven
    d. Twelve to sixteen
    e. Seventeen or above

20. Number of hours you regularly work (are employed) per week this semester
    a. Fewer than 5
    b. Between 5 and 10
    c. Between 10 and 20
    d. Between 20 and 40
    e. Over 40

21. Your income per year
    a. $3,000 or below
    b. $3,500 to $6,000
    c. $7,000 to $12,000
    d. $12,500 or above

22. Probable (or actual) major in college
    a. Social sciences (psychology, economics, history, sociology, political science, business)
    b. Humanities (English, foreign languages, music, art)
    c. Science (mathematics, biology, chemistry, geology, physics)
    d. Education (early childhood, elementary, secondary, special education)
    e. Undecided

23. Classification in college
    a. Freshman
    b. Sophomore
    c. Junior
    d. Senior
    e. Unclassified (special student)

24. Years you have attended college (full-time or part-time)
    a. Less than 1
    b. Between 1 and 2
    c. Between 2 and 4
    d. Between 4 and 6
    e. Over 6

25. Financial aid this year
    a. No aid awarded
    b. Loan and/or scholarship between $100 and $500
    c. Loan and/or scholarhsip worth between $500 and $1,000
    d. Loan and/or scholarship over $1,000
    e. All college expenses paid by outside sources

26. Religious affiliation
    a. None
    b. Catholic
    c. Jewish
    d. Protestant
    e. Other

Appendix D

Standardized Instruments

1. "Mathematics Anxiety Rating Scale," Rocky Mountain Behavioral Science Institute, Inc., Fort Collins, Colorado, 80521.
2. McDaniel, E.D.; Guay, R.; Ball, L.; and Kolloff, M. "Spatial Experience Qustionnaire," Department of Education, Purdue University, West Lafayette, Indiana 47907.
3. Nowicki, S. "Nowicki-Strickland Scale," Emory University, Atlanta, Georgia 30322.
4. Oltman, P.K.; Raskin, E.; and Witkin, H.A. "Group Embedded Figures Test," Consulting Psychologists Press, Inc., Palo Alto, California 94306.
5. Otis, A.S., and Lennon, R. "Otis-Lennon Mental Ability Test," The Psychological Corporation, Harcourt Brace Jovanovich, Chicago, Illinois 60648.
6. Rotter, J.D. "Generalized Expectancies for Internal versus External Control of Reinforcement," *Psychological Monographs: General and Applied* 80(1966):1–28.
7. Russell, J., and Hollander, S. "A Biology Attitude Scale," *The American Biology Teacher* 37, 5 (1975):270–273.
8. "School and College Aptitude Test," Cooperative Tests and Services, Educational Testing Service, Princeton, New Jersey 08540.

About the Book

[illegible]

[illegible]